同濟大學
TONGJI UNIVERSITY

## 硕士学位论文

# 现有绿色建筑标准的主要差异性：GBEL, DGNB, LEED 和 ÖGNB

## 一专注于新建筑和商业建筑

所在院系：建筑与城市规划学院

学科门类：建筑学

学科专业：建筑设计及其理论

二〇一五年九月

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A dissertation submitted to

Tongji University in conformity with the requirements for

the degree of Master of Architecture

# Key Diversity in existing Green Buildings Standards:

## GBEL, DGNG LEED and ÖGNB

**- focus on new construction and commercial buildings**

School/Department: College of Architecture and Urban Planning

Discipline: Architecture

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# 摘要

本文关注绿色建筑标准，基于的动机是如今大规模的建筑以及它对我们生活方方面面的影响。绿色建筑和标准不仅仅是一个政治现象：建筑师、投资者、开发商和房地产机构都参与到创造可持续发展建筑的活动中来。

绿色建筑在应对全球气候变化中能发挥举足轻重的作用。但对于一个真正的绿色建筑应该是什么样子的，目前还没有统一的共识。认证标准，设计和施工实践都多种多样，各有差异。

这个问题对建筑行业尤其重要因为建筑持续很长实践。一栋建筑的平均寿命是 80 年，而基础设施能维持到 120 年。因此，设计师责任重大。同其他的制造商和生产商一样，他们必须要为他们创作的作品细想新的，更可持续性的实践。但是，同等重要的是，设计者和建造者还必须考虑在一个建筑物的生命周期里如何它该如何可持续下去。

本文在全球气候变化和人口统计资料背景下分析了绿色建筑标准的未来。它概述了最著名和运用最广泛的绿色建筑标准以及它们的历史和目标。尤其关注了美国 LEED 标准，德国 DGNB,奥地利 ÖGNB 和中国 GBEL。我讨论了它们之间的主要区别以及它们的相似之处，并建议了它们未来可能会如何改变。

通过建立这四个标准的核心类目，使得现有标准的准则之间可相互对比，突出任务标准，并且建立计算系统来衡量这些标准，得出每个标准的重点所在。新的计算系统同时允许对性能指标进行全面的比较，指出在完成各自标准时，哪个系统所需的要求最高，哪个系统所需的要求最低。

我讨论了两者之间的主要差别以及他们的相同点，并且对将来如何利用它们开发现有的评级系统提出了建议。

**关键词：**绿色建筑标准；LEED；DGNB；ÖGNB；GBEL;标准；分类；压缩。

# ABSTRACT

This thesis focuses on green building standards, motivated by the huge scale of building today and the impact it has on all aspects of our lives. Green buildings and standards are not merely a political phenomenon: architects, investors, developers, and real-estate agencies are all involved in the movement to create sustainable buildings.

Green building standards could play an important role in combating global climate change. But there is no consensus as to what features a truly green building should have. There are many different certification standards, as well as widely varying design and construction practices.

This problem is particularly important for the building industry because buildings last so long. A building's average lifespan is eighty years, while infrastructure can last up to 120 years. So, designers bear a heavy responsibility. Like other manufacturers and producers, they must consider new, more sustainable practices for the creation of their work. But, just as importantly, designers and builders must also consider how sustainable a building will be over the course of its lifetime.

This thesis analyses the future of green building standards in the context of changes in global climate and demographics. It gives an overview of the best-known and most widespread green building standards, including their history and their aims. It focuses particularly on the American LEED standard, the German DGNB, the Austrian ÖGNB, and the Chinese GBEL.

By developing new core categories for these four standards, into which all categories and criteria present across them can be mapped, it is possible to compare their existing criteria with each other to highlight those that are missing. It also becomes possible to create a calculation system that identifies how the categories and criteria are weighted and to show where the focus of each standard is. The new calculation system also allows us to create a total performance index for comparison, to point out which systems have the toughest and weakest requirements.

The thesis discusses the key differences between the systems as well as their similarities, and suggests how they might be further developed in the future.

**Key Words:** green building standards; LEED; DGNB; ÖGNB; GBEL, criteria; categories; compress

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# 1. Introduction

## 1.1 General

In July 2015, experts from the United Nations Department of Economic and Social Affairs (UNDESA) calculated that the world population will rise to 9.7 billion by 2050. This was 170 million more than expected by previous estimates. The UN predicts that 11.2 billion people will live on earth by 2100, 300 million more than the last forecast predicted.

Just several months earlier, the International Energy Agency (IEA) released the World Energy Outlook for 2015, stating the following:

> In the New Policies Scenario, energy demand grows by 37% to 2040 on planned policies, an average rate of growth of 1.1%. … Energy demand growth shifts decisively away from OECD countries. China dominates energy demand growth until the mid-2020s, but as its population levels off and its economic growth slows around that time, India takes over as the leading engine of energy demand. … World oil supply rises by 14 mb/d to 104 mb/d in 2040. … All major regions, except Europe [,] contribute to the more than 50% rise in natural gas output.[1]

> Every major scientific and research organisation, including the Intergovernmental Panel on Climate Change (IPCC) agree that the results of continuing present

[1] International Energy Agency, "World Energy Outlook 2014 Factsheet: How will global energy markets evolve to 2040?", accessed 31 August 2015, http://www.worldenergyoutlook.org/media/weowebsite/2014/141112_WEO_FactSheets.pdf

> population and consumption trends could be catastrophic. We know the possibilities, and we know that something must change.

In this thesis, I will focus on attempts to reduce energy use in the world's biggest energy-consumption sector. Contrary popular misconceptions, this is not industry or transportation, but building. According to the United Nations Environment Programme (UNEP),

> buildings use about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 1/3 of GHG [greenhouse gas] emissions … Residential and commercial buildings consume approximately 60% of the world's electricity.[2]

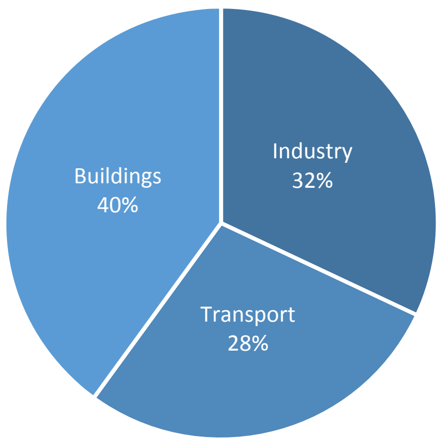


**Figure 1.1. Total Final Consumption by sector 2014[3]**

Key words like *green building*, *sustainability*, and *carbon footprint* are well known in discourse about energy use and climate change, and many countries have developed their own green building standard. Green buildings and associated standards are not merely a political phenomenon: architects, investors, developers, and real-estate agencies have increasingly paid attention to the movement towards creating sustainable

[2] United Nations Environment Programme, "Why Buildings," accessed 7 August 2015, http://www.unep.org/sbci/AboutSBCI/Background.asp
[3] OECD, accessed 31 August 2015, http://www.stats.oecd.org.

buildings. At present, there are numerous certification standards for green buildings, which creates confusion about the features that are genuinely necessary for sustainable buildings, and also creates disparities in design and construction practices and outcomes.

To achieve a more sustainable future, architects should focus on buildings that serve the mass of humanity—not just glossy projects like shopping malls, office towers and high-rise multiresidential buildings. An expanded focus is necessary to deal effectively with the major world issues of providing suitable housing and addressing climate change, which frequently collide and exacerbate each other every year.

The urban built environments in cities all over the world create over 35% of global greenhouse gas emissions. By 2030, over 80 billion m² of new and rebuilt buildings will be constructed in urban areas worldwide—an area equal to 60% of the world's entire current building stock.[4]

The colossal scale and impact of world building activity motivates the present thesis's focus on green building standards. I will ask which are the best, and "greenest" standards, and what are the key points that differentiate them.

The promotion of green building standards represents a significant opportunity to change the future world climate. It also presents a considerable burden of responsibility, because in the field of design and construction, we can look at emission patterns for the next 80 to 120 years, 80 being the average global lifespan for a building and 120 the lifespan for infrastructure.

In Part I of this thesis, I will give an overview of the most known and widespread green building standards in the world. This will include information on their history, the main issues they target, and the country from which they come. There will be a particular focus on the world's biggest energy consumers, the People's Republic of China (China) and the United States of America (the US). These two countries represent Asia and North America; in Europe, I focus on Germany, the continent's biggest energy consumer. As a contrast to the other countries selected, I also focus on Austria, which

[4] UN Habitat, State of the World's Cities 2010/11: Cities for All—Bridging the Urban Divide (New York: Earthscan, 2008).

is only the world's 50th-largest $CO_2$ emitter as a country, but the 22nd-largest in per capita terms, right after Germany at number 21 and before China at number 23.

In summary, my primary focus lies on the following green building standards, and specifically on their new building, retail/office, and residential categories):

- DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) – Germany (e.V: German Sustainable Building Council)
- LEED (Leadership in Energy & Environmental Design) – US
- GBEL – China
- ÖGNB (Österreichische Gesellschaft für Nachhaltiges Bauen) –Austria (e.V: ASBC – Austrian Sustainable Building Council)

Part I will also compare those four green building standards to identify their key features and differences. The aim is to help planners, architects, and engineers find the most suitable standards for their projects, and to point out directions for further development of these standards that could make them even "greener".

## 1.2 Future living, future building

The United Nations Human Settlements Programme (UN-Habitat) has published the staggering statistic that 300 million people will need a new, affordable home in the next 20 years.[5] This not only reflects world population growth, but also shows how big the market will be for architecture, and how important the topic of green building. By 2030, over 80 billion m² of new and rebuilt buildings will be constructed in urban areas worldwide.

Increasing the efficiency of those buildings presents a huge opportunity to change the outlook for the world's climate and natural environment. The building sector in industrialised countries are responsible for 40% of the energy consumption, 38% of greenhouse gas emissions, 12% of drinking water consumption, and 40% of solid waste.[6] Though this represents a tremendous burden on the world's resources, it also represents a significant opportunity to reduce that burden.

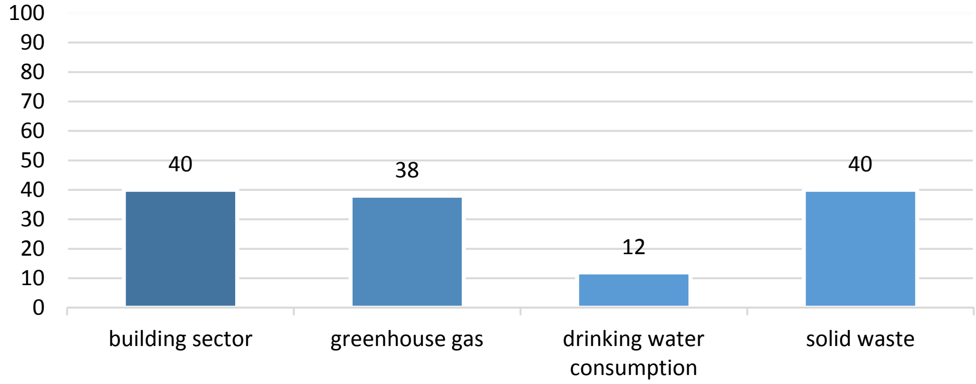


**Figure 1.2. Industrialised countries' building-sector consumption**

Planners and architects must aim to design and create a built environment that combines the highest quality of life with the highest conservation of resources. In

[5] UN-Habitat, Adapted from Stat of the World Cities 2010/11, McKinsey Global Institute.
[6] United Nations Environment Program-Sustainable Buildings and Climate Initiatives "Building Design and Construction: Forging Resource Efficiency and Sustainable Development," (UNEP-SBCI).

support of this, it is important to design and develop tools, certification standards, and rating systems to measure and compare buildings at a country and international level. Today, there is an enormous variety of green building certification standards, and in Table 1.1 ‘Green Building certification standards worldwide’ you can see the most significant standards broken down by country.

Green building standards may be numerous, but there is an even wider range of definitions for what constitutes a green building. The most suitable and precise definition could be this one from the United States Office of the Federal Environmental Executive (OFEE): because it contains every aspects which are relevant for Green buildings and it divides them in two categories.

> The practice of (1) increasing the efficiency with which buildings and their sites use energy, water and materials, and (2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance and removal – the complete building life cycle.[7]

As noted, many countries have introduced and developed their own rating tools. Some, like the US, Germany, and the Philippines, even have more than one. Yet, if world climate change is a global problem, why is there not a global standard? There are multiple possible reasons for this: foremost among them are the presence of different climate zones around the world, and the individual characteristics and aims regarding their political, economic, social, and ecological development. These factors must be analysed to understand the development of the green building sector in each country under investigation.

[7] Office of the Federal Environmental Executive, “The Federal Commitment to Green Building: Experiences and Expectations,” accessed 31 August 2015, http://www.ofee.gov/sb/fgb_report.asp.

| Country | Green Building Standard |
|---|---|
| Australia | Nabers \| Green Star |
| Austria | ÖGNB \| ÖGNI \| TQB 2002 \| IBO \| Klima:aktiv |
| Brazil | AQUA \| LEED Brasil |
| Bulgaria | BGBC |
| Canada | LEED Canada \| Green Globes \| Build Green Canada |
| China | GBAS \| GBEL |
| Denmark | Greeen Building Council Denmakr |
| Finland | PromisE |
| France | HQE |
| Germany | DGNB \| CEPHEUS \| BNB \| BREEAM DE |
| Hong Kong | HKBEAM |
| India | IGBC \| GRIHA |
| Indonesia | GBCI \| Greenship |
| Italy | LEED Italy \| Protocollo Itaca \| GBCouncil Italia |
| Japan | CASBEE |
| Korea | KGBC |
| Malaysia | GBI Malaysia |
| Mexica | LEED Mexico |
| Netherland | BREEAM Netherlands |
| New Zealand | Green Star NZ |
| Philippines | BERDE \| Philippine Green Building Council |
| Portugal | Lider A |
| Taiwan | China Green Building Network |
| Thailand | ARGE Archimedes Facility–Management GmbH \| Bad Oeynhausen & RE / ECC \| Chonburi |
| Singapore | Green Mark |
| South Africa | Green Star |
| Spain | VERDE |
| Switzerland | Minergie \| SGNI |
| USA | LEED \| Living Building Challenge \| Green Globes \| Build it Green \| NAHB NGBS \| International Green Construction Code \| ICC 700 |
| United Kingdom | BREEAM |
| United Arab Emirates | Estidama |
| Jordan | EDAMA |
| Czech Republic | SBToolCZ |

**Table 1.1. Green Building certification standards worldwide**

## 1.3 Global change

Change is a constant companion in today's global and highly technological society, and this is unlikely to change at any time in the next 100 years—for the next three generations.

In our daily lives, we are constantly confronted with the results of the previous generation's actions. There is sufficient scientific proof to uphold the observation that human activities are the main contributors to recent climate change, and at the same time climatologists agree the global temperature increase must be kept under 2°C to avoid the most risks. The graph in Figure X illustrates how global surfaces temperatures have changed relative to averages. The ten warmest years on record since 1880 all occurred after 2000, and the year 2014 was the warmest year on record. Since 1880, the global temperature has risen about 0.9°C. Of this increase, 0.74ºC occurred in the past 100 years, and 0.65°C in just the last 50.[8]

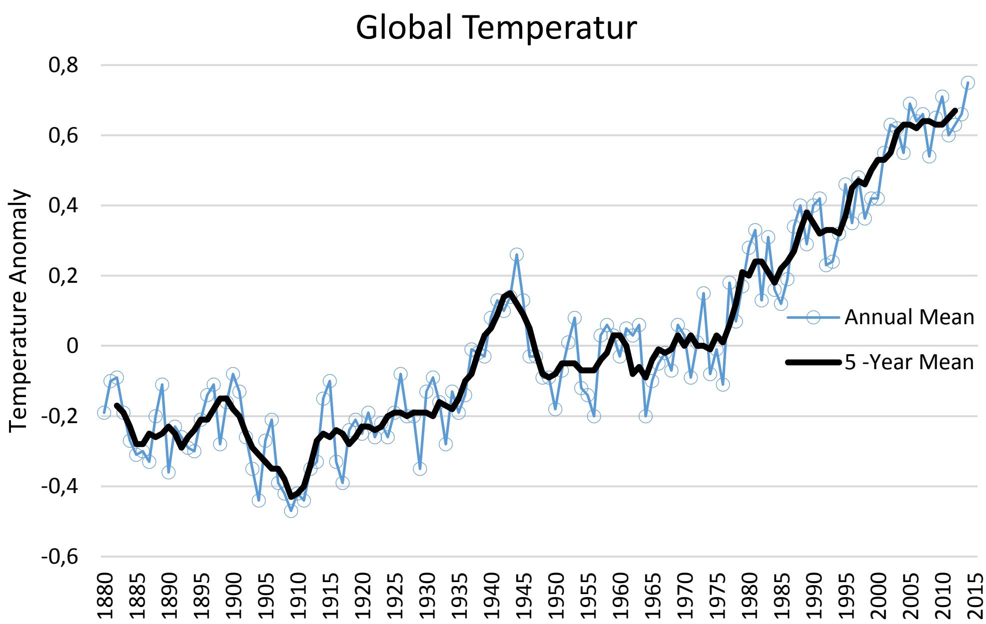


**Figure 1.3. Global Temperature**

[8] Goddard Institute for Space Studies, GISS Surface Temperature Analysis, Global Mean Surface Air Temperature Change, accessed 31 August 2015, http://www.data.giss.nasa.gov/gistemp/graphs_v3/

This graph illustrates the change in global surface temperature relative to 1951-1980 average temperatures. The 10 warmest years in the 134-year record all have occurred since 2000, with the exception of 1998. The year 2014 ranks as the warmest on record.[9] This research is broadly consistent with similar constructions prepared by the Climatic Research Unit and the National Oceanic and Atmospheric Administration.[10]

This increasing temperature has caused several climatic changes, the most obvious being desertification and the growth of arid zones around the world. As a consequence of increasing temperatures, scientists have observed a reduction of global snow cover. The thickness of polar ice caps has decreased, and sea levels have risen. Intense rainfall is becoming more frequent, creating a significant increase in the number of floods. The incidence of hurricanes and tornados has also risen, causing an increasing amount of damage, and, finally, climate change is disturbing natural ecosystems and contributing to the extinction of animal and plant species. Scientists have long shown us a correlation between the rise of global temperatures and the increase in emissions of greenhouse gases: carbon dioxide, methane, nitrogen oxide, ozone, and hydrofluorocarbons. Of these, carbon dioxide is the primary concern.

Over a recent 40-year period—1972 to 2012—the World Meteorological Organization recorded almost 9,000 extreme weather events that took 2 million people's lives. Averaging those numbers, it means that every year there are roughly 200 weather-related disasters, causing around 45,000 deaths in total and $60 billion in damage.

Here is a list of the countries most affected by extreme weather events from 1994 to 2013.

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[9] University of East Anglia, Climatic Research Unit, access 31.Augsut 2015 http://www.cru.uea.ac.uk/,

[10] National Oceanic and Atmospheric Administration; State of the Climate http://www.ncdc.noaa.gov/sotc/summary-info/global/201507

| CRI | Country | Death toll | Total losses in million US$ PPP | Losses per unit GDP in % | Number of total events |
|---|---|---|---|---|---|
| 1 | Honduras | 309.70 | 813,56 | 3,30 | 69 |
| 2 | Myanmar | 7137.40 | 1256,20 | 0,87 | 41 |
| 3 | Haiti | 307.80 | 261,41 | 1,86 | 61 |
| 4 | Nicaragua | 160.15 | 301,75 | 1,71 | 49 |
| 5 | Philippines | 933.85 | 2786,28 | 0,74 | 328 |
| 6 | Bangladesh | 749.10 | 3128,80 | 1,20 | 228 |
| 7 | Vietnam | 391.70 | 2918,12 | 1,01 | 216 |
| 8 | Dominican Republic | 210.45 | 274,06 | 0,37 | 54 |
| 9 | Guatemala | 83.20 | 477,97 | 0,62 | 80 |
| 10 | Pakistan | 456.95 | 3988,92 | 0,77 | 141 |
| **22** | **Germany** | **42.67** | **3842,95** | **0,143** | **NA** |
| **26** | **China** | **1556,20** | **42535,42** | **0,523** | **NA** |
| **26** | **USA** | **467,45** | **45305,64** | **0,377** | **NA** |
| **41** | **Austria** | **26,95** | **567,80** | | **NA** |

**Table 1.3. Climate risk index for 1994–2013 11**

At present, the sea level is rising at a rate of 3.20mm per year. In the period from May 1997 to March 2015, the sea level rose a total of 64.29mm, caused by the expansion of water as it warms and by melting land ice in the Arctic and Greenland. The Antarctic land ice mass has been losing more than 130 billion metric tons of ice per year, and Greenland's situation is worse. Around 287 billion metric tons of land ice is currently being lost every year, and this loss will continue.

[11] S. Kreft, D. Eckstein, L. Junghans, C. Kerestan U.Hagen, Global Climate Risk Index 2015 (Germanwatch), 24–31.

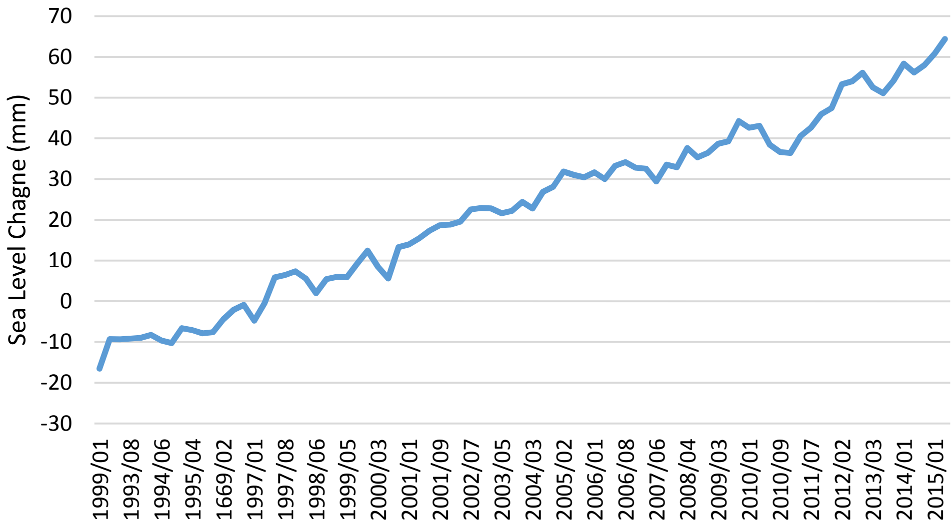


**Figure 1.4. Sea level from 1999 to 2015**[12]

The Antarctic land ice mass has been losing more than 130 billion metric tons of ice per year, and Greenland's situation is worse. Around 287 billion metric tons of land ice is currently being lost every year, and this loss will continue.

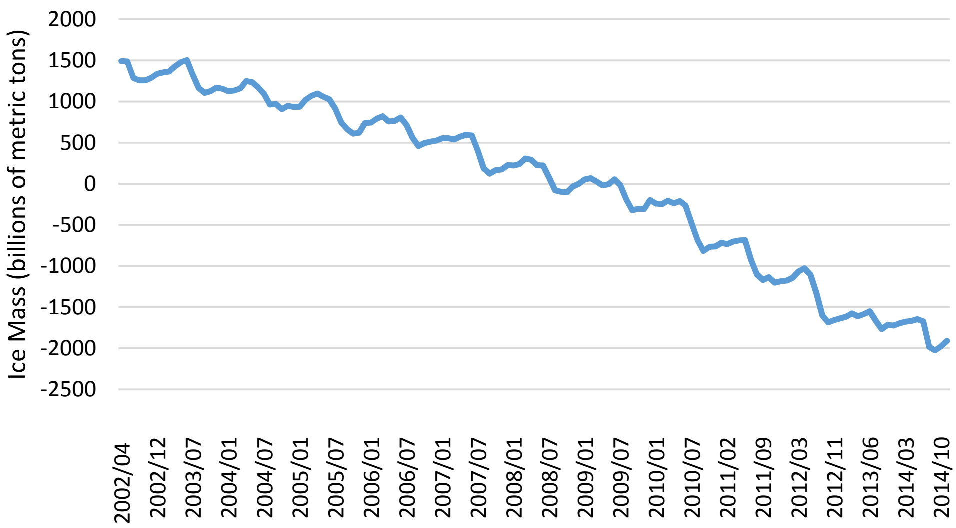


**Figure 1.5. Antarctica mass variation since 2002**[13]

[12] NASA; access August 2015 Infographic Sea level riseclimate. http://www.nasa.gov/
[13] NASA; access August 2015 Antarctica Mass variation climate. http://nasa.gov/vital-signs/land-ice/

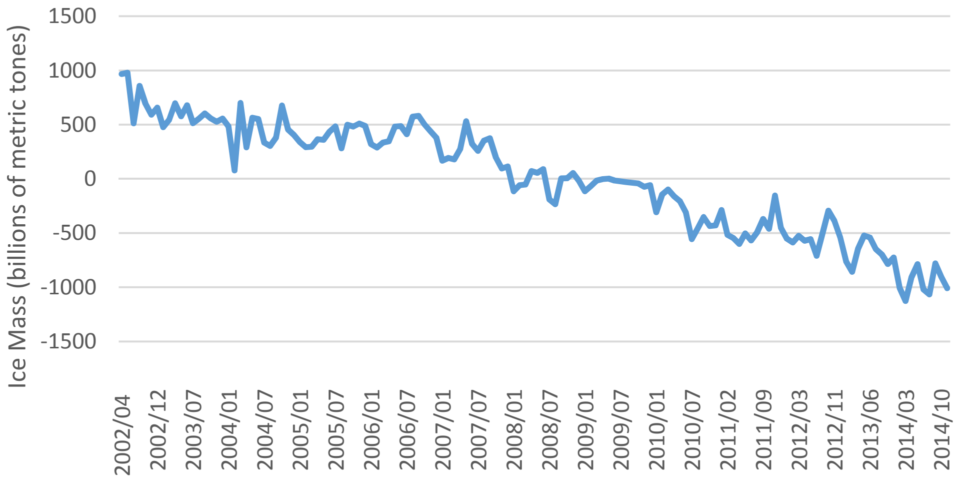


**Figure 1.6. Greenland mass variation since 2002**[14]

The increase in greenhouse gas concentration responsible for global warming is due to human activity, chiefly manufacturing industry, transportation, residential building, and service provision.

This thesis focuses on the building sector, which is the largest contributor to global energy consumption. This sector includes not only buildings, but also outdoor lighting and road construction. The United Nations Environment Programme (UNEP) released some key facts about the building sector in 2014:

- The building sector is estimated to be worth 10% of global GDP ($7.5 trillion) and employs 111 million people.
- Residential and commercial buildings consume approximately 60% of the world's electricity.
- Existing buildings represent significant energy saving opportunities because their performance level is frequently far below current efficiency potentials.
- The building sector is the largest contributor to global GHG emissions.
- In developing countries, new green construction yields enormous opportunities. Population growth, prosperity and increasing urbanisation fuel building and construction activities, represent up to 40% of GDP.[15] [..]

[14] NASA, "Land Ice," accessed 31 August 2015, http://www.climate.nasa.gov/vital-signs/land-ice/.
[15] United Nations Environment Programme, "Buildings", access 01. August 2015 http://www.unep.org/sbci/AboutSBCI/Background.asp

If we divide the 40% of global energy use accounted for by the building sector into residential and commercial portions, we see that 22% of global energy use comes from residential buildings and 18% from commercial buildings.

The following diagrams from the US Department of Energy (DOE) show further divisions of energy use in each sector.

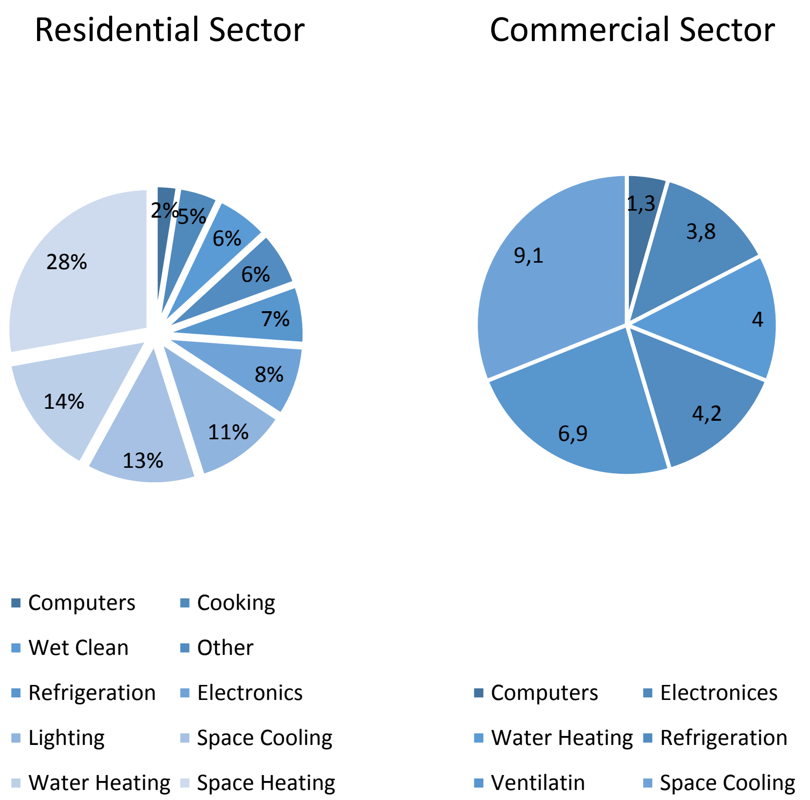


**Figure 1.7. (Left) Energy consumption in the residential sector. (Right) Energy consumption in the commercial sector.**[16]

[16] *DOE*, 2011 Buildings Energy Data Book, Section 2.1.5, March 2012, http://buildingsdatabook.eren.doe.gov/.

Current data show that China and North America are the world's leading $CO_2$ emitters, followed by India and Russia. But if we look at $CO_2$ emitters per capita, China is in 23rd place, after Germany and Austria. The top emitters per capita are Qatar, Trinidad and Tobago, and Singapore.

Furthermore, Figure 1.10 'Cumulative energy related to CO2 emissions by region' shows the cumulative rise of energy-related $CO_2$ emissions. It shows an interesting development: while the United States and the European Union have an almost continuous rise, from the 60s to the 80s the United States took over as the leading emitter. The graph also shows how China and the "rest of the world" Figure 1.8 'World $CO_2$ emitters by energy consumption in 2014' recorded a rise in emissions stating in the 1960s to 1980s, which has become very significant in the past 30 years.

By taking a detailed look at the builidng-sector energy consumption of certain countries during this period, we can see divergent evolution that shows interesting details. Within the European Union countries, for instance, there can be big differences: while Germany held its level, for instance, Austria's consumption increased markedly.

By dividing consumption of residential and non-residential buildings, the charts also show that Germany and Austria's consumption were equally distributed across both sectors. Yet in Chinese buildings, there is an enormous difference between residential and non-residential buildings, with around 10 times more consumption on the residential side. In the United States, both sectors have almost the same energy consumption.

Though there are different perspectives on how to address climate change, it remains a global issue and we should not necessarily hold individual states responsible. If we don't change our habits as a species, the temperature will increase further, leading to further extreme weather conditions and increasingly alarming repercussions. Political solutions must be found to the problem, including guidelines and laws that bind all countries around the world.

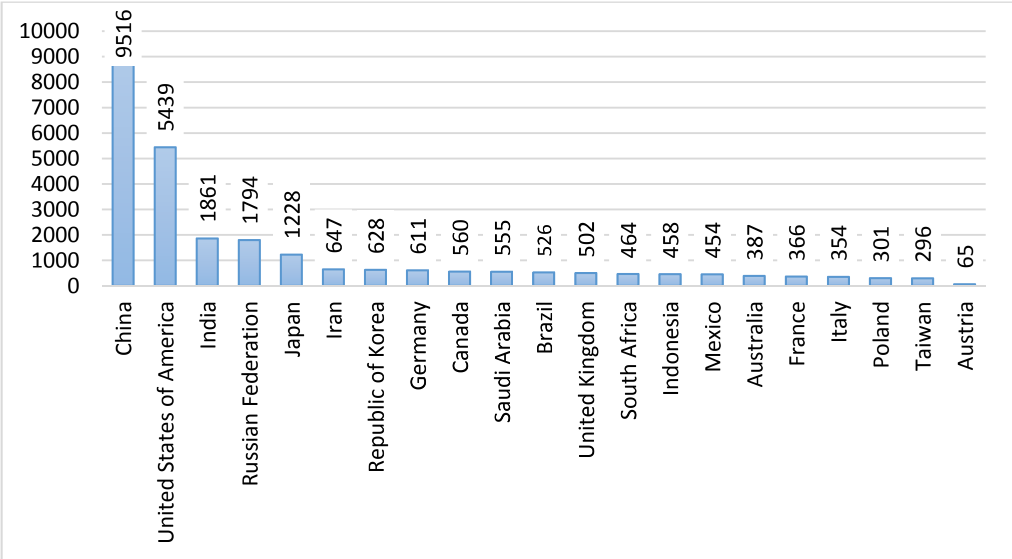


**Figure 1.8. World $CO_2$ emitters by energy consumption in 2014**[17]

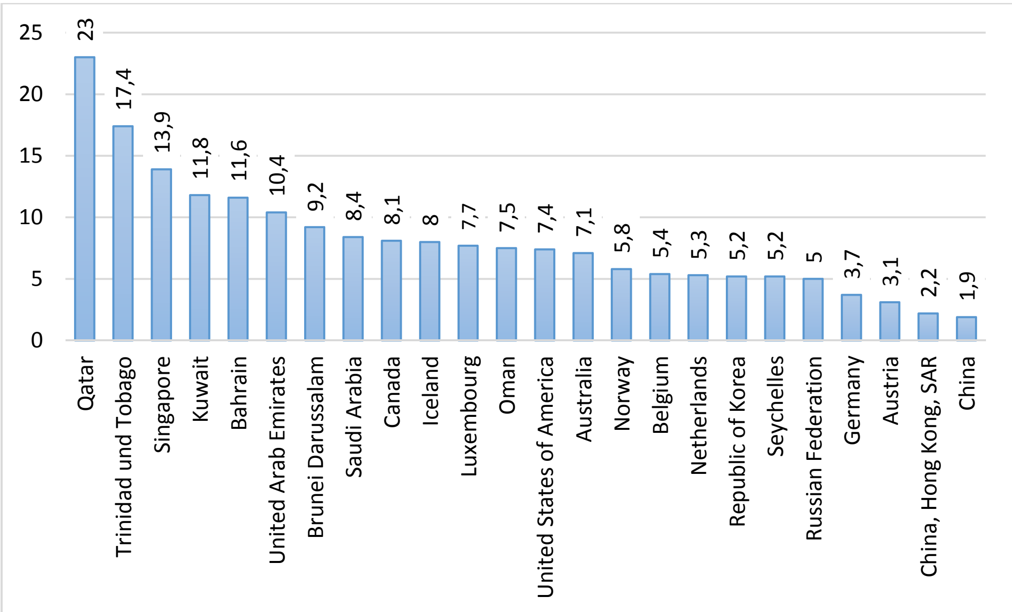


**Figure 1.9. World $CO_2$ emitters by per capita energy consumption**[18]

[17] U.S.Energy Information Administration August 2015 International Energy Statistic access USseia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=44&pid=44&aid=2
[18]U.S.Energy Information Administration August 2015 International Energy Statistic access Aueia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=44&pid=45&aid=2&cid=ww,&syid=2008&eyid=2012&unit=QBTU

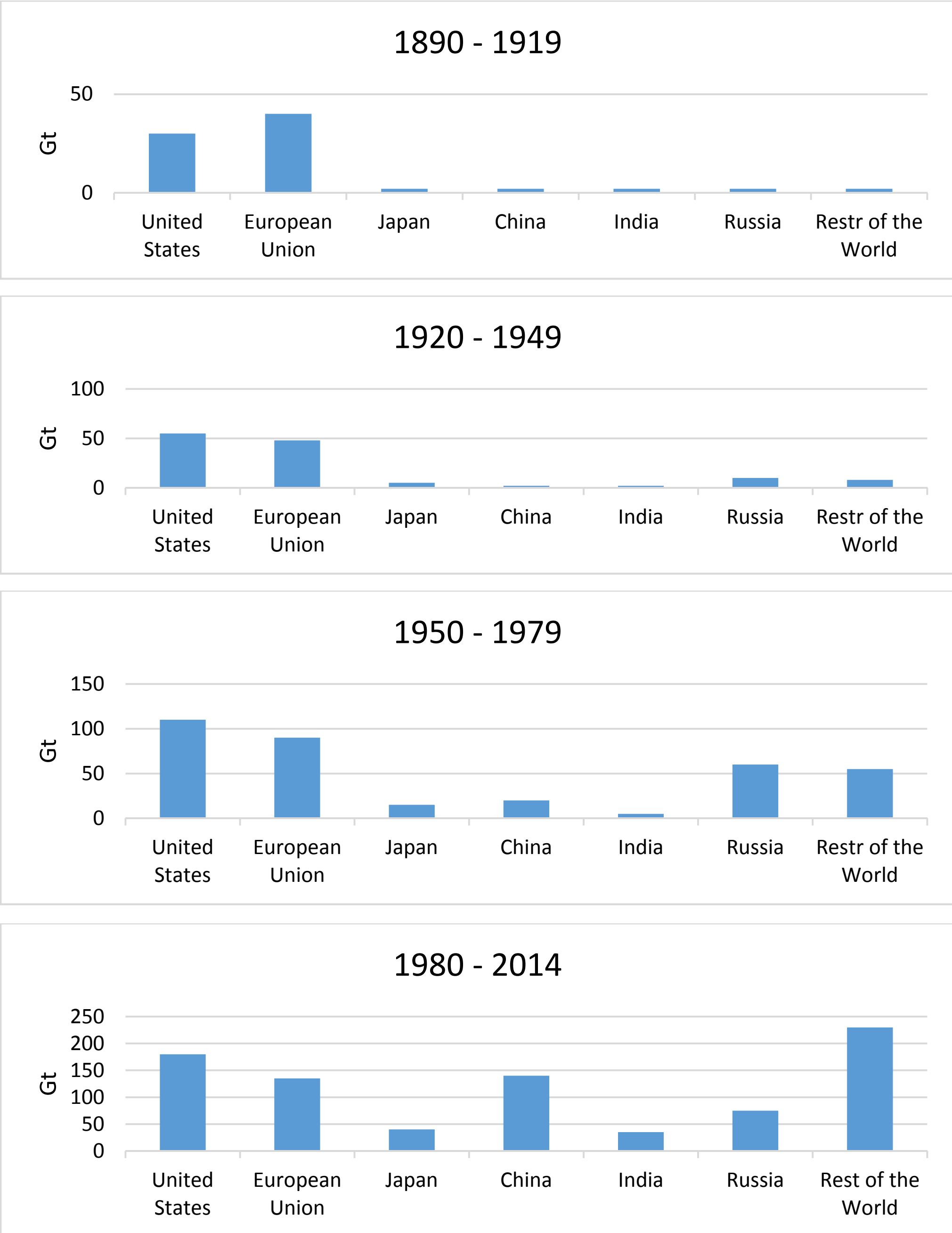


**Figure 1.10. Cumulative energy related to $CO_2$ emissions by region**

Note: Emissions for the European Union prior to 2004 represent the combined emissions of its current member states. Emissions for Russia prior to 1992 represent emissions from Union of Soviet Socialist Republics. "Rest of the World" includes international bunkers[19]

[19] Marland, Boden and Andres (2008) and IEA (2014a) Energy and Climate Change, Historical energy emissions trends (2015); 25-28

# 1.4 Building-sector energy consumption

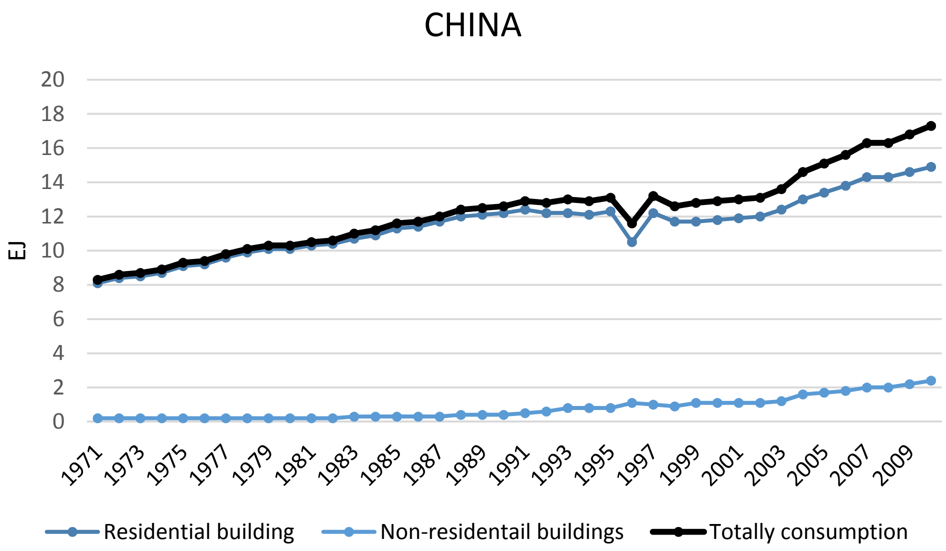


**Figure 1.11. China's energy consumption 1971–2010**[20]

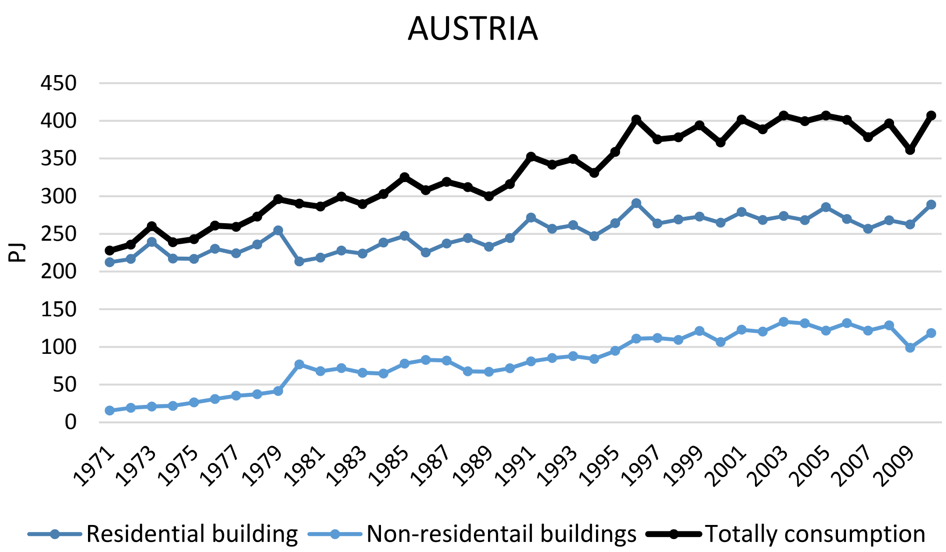


**Figure 1.12. Austria's energy consumption 1971–2010**[21]

[20] International Energy Agency (IEA), "Building Energy Efficiency Policies: China," accessed 30.August 2015, http://iea.org/beep/china/

[21] IEA, "Building Energy Efficiency Policies: Austria," accessed 30 August 2015, http://iea.org/beep/austria/.

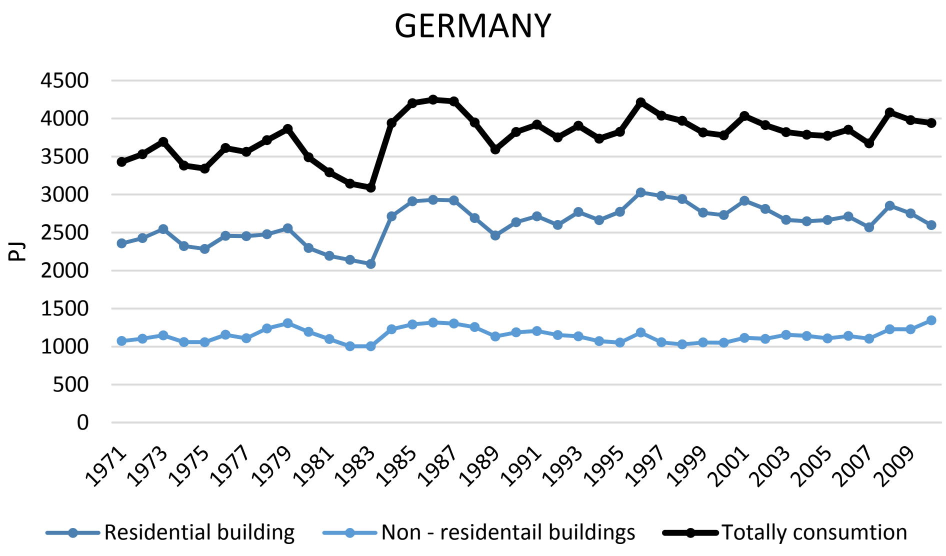


**Figure 1.13. German building-sector energy consumption**[22]

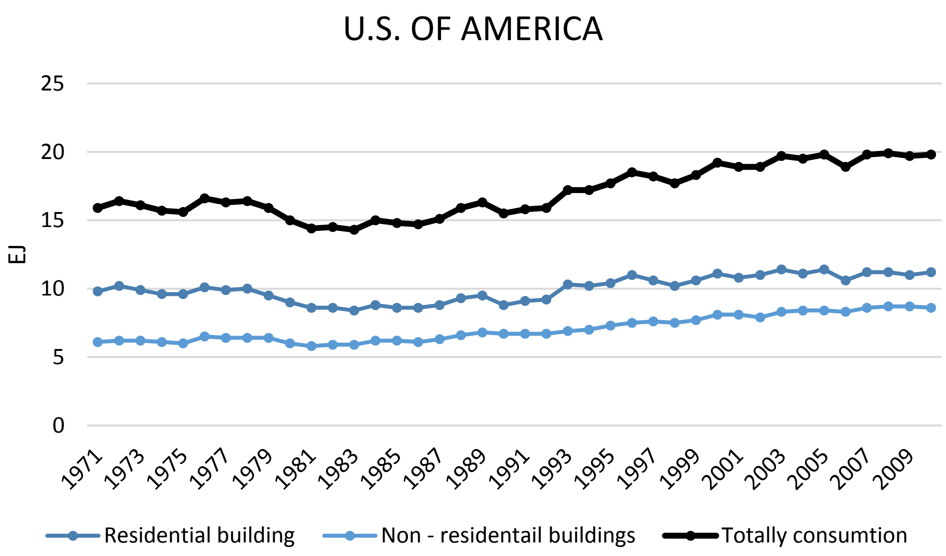


**Figure 1.14. US building-sector energy consumption**[23]

[22] IEA, "Building Energy Efficiency Policies: Germany," accessed 30 August 2015, http://iea.org/beep/germany/.
[23] IEA, "Building Energy Efficiency Policies: United States," accessed 30 August 2015, http://iea.org/beep/united%20states/.

## 1.5 The politics of climate change

When we talk about the issue of global climate change and its effect on the environment, the Kyoto Protocol is one of the key reference points.

The United Nations has 193 members, while the US Department of State recognises 195 independent countries. The first round of the Kyoto Protocol included nearly every country in the world, excluding only except Andorra, Southern Sudan, Taiwan, and Vatican City. The United States signed but has not ratified the protocol, while Canada withdrew in 2011.

The Kyoto Protocol's history started at the United Nations Conference on the Human Environment (UNCHE), held in Stockholm in 1972. It was the first UN conference on the issue of the environment, and is considered the starting point for global environmental policy. More than 1,200 officials from 113 countries agreed to 26 principles or declarations related to the care of the environment in future (see chapter Appendix I, Annex).

The second UNCHE took place two decades later in Rio de Janeiro, and is better known as the "Earth Summit". This time, more than 10,000 officials from 178 countries took part. The two weeks of the conference produced five documents, of which some of the best known are Agenda 21 and the Rio Declaration on Environment and Development. The United Nations Framework Convention on Climate Change (UNFCCC), an international agreement with the aim of stopping global warming, includes a treaty for reducing greenhouse gas emissions and was also opened for signing at Rio.

After the convention in Rio, the first conference of the parties (COP) was held in 1995 in Berlin. The COP includes the countries that have signed the UNFCCC; at the conference they discuss further strategies for preventing climate change. The most important of these conferences took place in 1997 in Kyoto, and was the foundation of today's Kyoto Protocol.

The central idea of the protocol was that by 2012, the world would reduce greenhouse gas emissions by 5.2% when compared to the base year of 1990. This was a binding commitment for all countries who signed the agreement. The 5.2% was a global target, though developed countries were expected to make a greater contribution, and had more ambitious reduction targets. For example, Germany committed to reducing emissions by 21%, and Austria to a 13% reduction. On the other hand, some countries were allowed to increase their emissions, including Iceland and Spain.

The Kyoto Protocol also called for a greenhouse gas emission trading program, which was established and launched in 2004 when Russia decided to ratify the protocol. One main prerequisite for the establishment of such a program was that the number of parties to ratify the protocol collectively account for 55% or more of world $CO_2$

emissions

By 2012, several countries had managed to fulfil their target, as you can see in Figure 1.15. ‘Kyoto Protocol targets and actual $CO_2$ emissions’.On the other hand, some failed completely. Austria, for example, had to buy greenhouse gas emission certificates valued at €500 million to fulfil its obligations. The positive aspect of this trading system, is that theoretically doesn’t matter where the greenhouse gas emission is produced or reduced but a major problem with the trading system is that a massive surplus of certificates caused the market price to fall dramatically. Caused by the economic crisis. Furthermore it could support criminal act to make profit with this system (see chapter 6.’Discussion’).

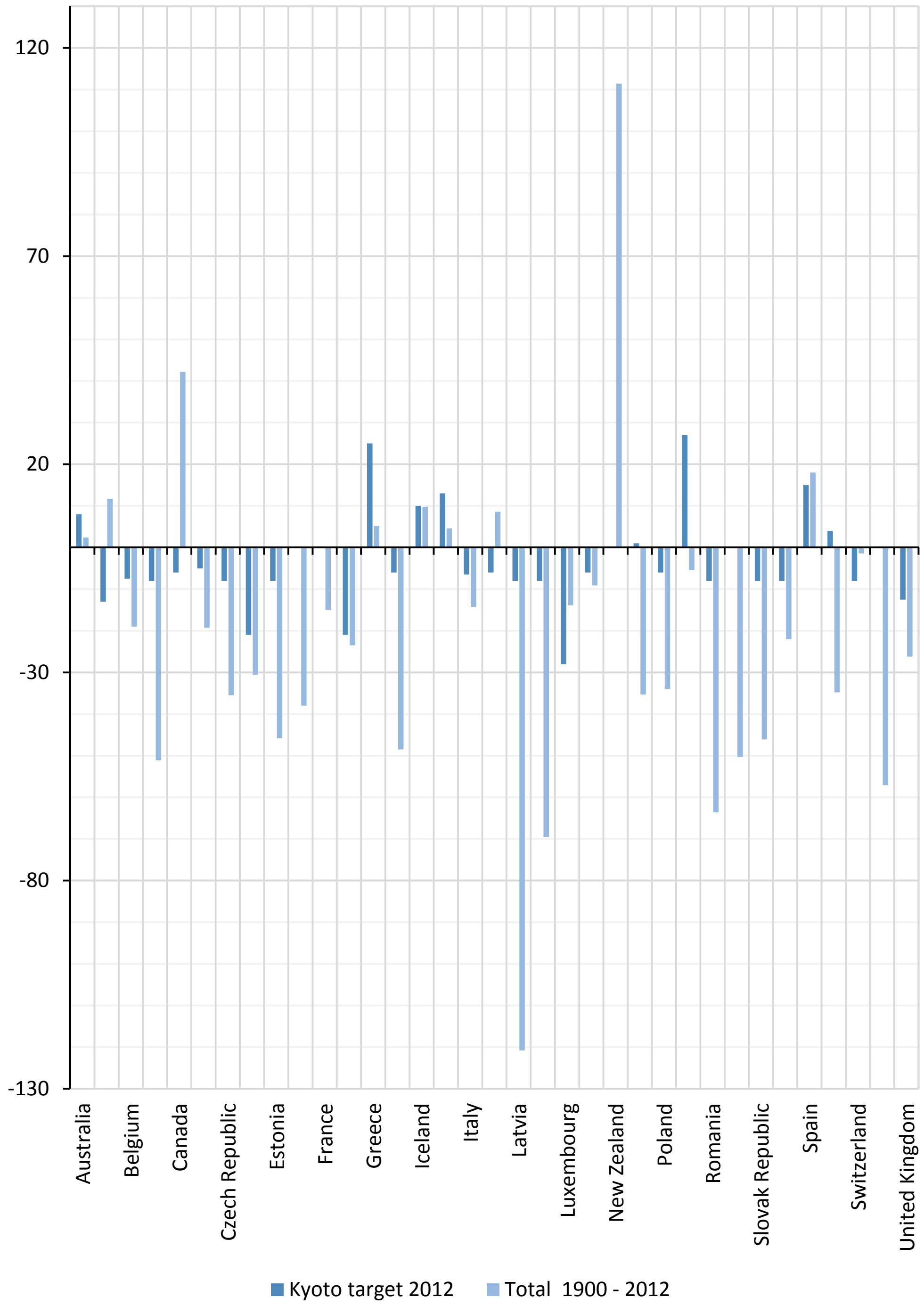


**Figure 1.15. Kyoto Protocol targets and actual $CO_2$ emissions**[24]

[24] The Guardian, "Has the Kyoto protocol made any difference to carbon emissions?" accessed 22. August 2015, http://www.theguardian.com/environment/blog/2012/nov/26/kyoto-protocol-carbon-emissions

At the 18th conference of the parties in Doha on September 2012, 194 countries agreed to work toward a universal agreement on climate change. Furthermore, they developed and adopted a second agreement, the Doha Amendment, which extends to the year 2020. Yet today, just 37 countries have ratified it, and together, they account for just 15% of worldwide greenhouse gas emissions. The plan in the Doha Amendment is to reduce greenhouse gas emissions by 25–40%, from the 1990 base, by 2020.

The more important resolution in Doha was that the participating countries agreed to a new global climate treaty, which included the US. China and India were also to be on board. But so far, the USA, China, and India have never agreed on a binding contract that sets targets for 2020. Climate organisations such as Greenpeace and Germanwatch have criticised plans as too weak, insufficient to keep the world global temperature increase less than 2ºC.

## 1.6 World demographics

In 1800, the world population was about 1 billion people. It reached around 2 billion 127 years later, in 1927, and 2.5 billion in 1950. At that time, Asia had 52% of the world's population, while 17.6% was in Europe (21.7% if you include Russia), 13.4% in the Americas combined, and just 9% in Africa. The Middle East had 3.4% and Australia just 0.5%. By 2005, the world population had more than doubled the level of just 65 years earlier, to 6.5 billion people. The UN now predicts that there is a 80% probability that by 2030 the population will be between 8.4 and 8.6 billion.

Today, the population is rising more in developing countries than in the industrialised ones, where birth rates have fallen significantly, often to below the replacement rate. Looking at population on a regional basis, in north-east Asia it is predicted to decline by 2.8% by 2030, while in south-east Asia it will grow by 7.5%. Europe and Africa will also experience significant changes. Together, both continents will have more than 25% of the world's population, but they are moving in different directions: Africa's population will rise by 10% while Europe's falls by 10%.

By 2050, the prediction is that the world population will be around 9.5 billion, while by 2100 it will be 11.2 billion. There are several reasons for this massive population growth over the three centuries since 1800, among them medical advances and the resulting rise in life expectancy and lowering of mortality rates. Today, this is somewhat counterbalanced by lower birth rates as a result of education, birth control, and lower infant mortality.

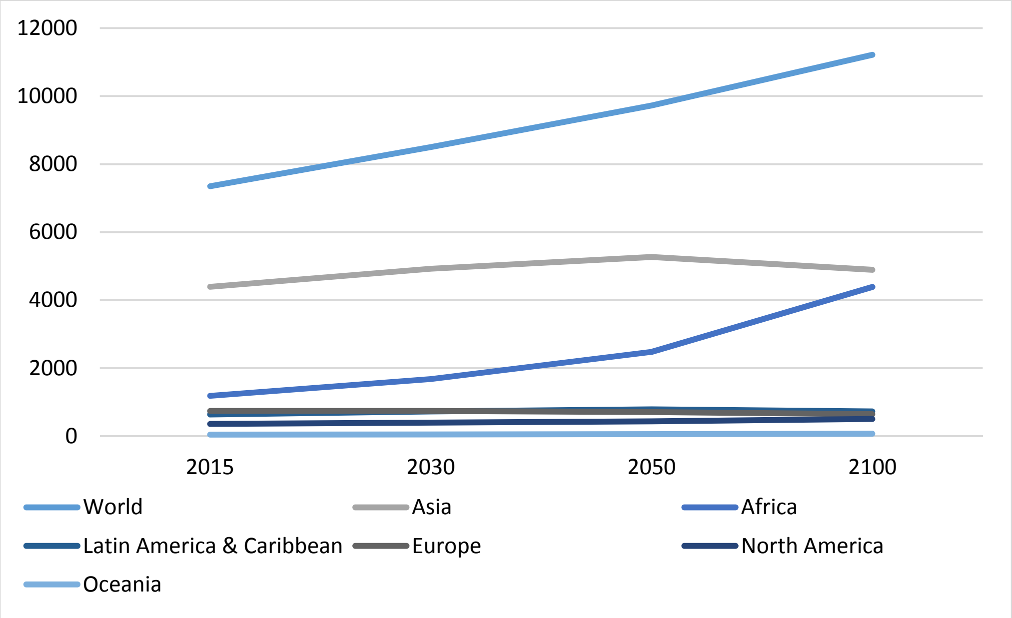


**Figure 1.16. Projected world population, in millions** [25]

Predictions for worldwide population distribution in 2050 include that industrial countries like Europe, Japan, Australia, the US and Canada will collectively be home to around 1 billion people, as they are today. Only in the USA will the population rise, due to a birth rate of around 2.11 combined with immigration. In the rest of the world, the population will rise from 5 billion to 8 billion.

Another major demographic trend is that populations will continue to urbanise. In 1975, there were five cities with a population of more than 10 million: Tokyo, Shanghai, New York, Mexico City and São Paulo. In 2015, there are 34 so-called megacities of more than 10 million people.[26]

[25] UN, Department of Economic and Social Affairs, Population Division, "World Population to 2300" New York 2014
[26] Wikipedia contributors, "Megacity," *Wikipedia, The Free Encyclopedia*, accessed 31 August 2015, https://en.wikipedia.org/w/ index.php?title=Megacity&oldid=678603038.

Additional factors in population growth are increased life expectancy, which leads to an ageing population, and immigration.

As a consequence of population growth and urbanisation, between now and 2030, over 80 billion m² of new and rebuilt buildings will be constructed in cities worldwide. This total floor area is equal to 60% of the world's entire building stock at present.

The huge amount of building activity expected in the near future is one reason the building sector plays such an important role in the issue of climate change —making green and sustainable building certifications more and more important. In recent decades, not just the total number of building certifications but also the number of certified buildings has increased tremendously. Besides standards, norms, guidelines and certifications from institutional and governmental organisations, there are more than 600 methods to measure building sustainability.[27]

Most building rating tools are national, though in the past few years some have tried to accommodate variable climate zones, which makes them easier to adapt to other countries. Worldwide there are five basic climate zones: tropical, dry, temperate, cold, and polar. These five can (and must) be further divided for greater accuracy when it comes to determining appropriate building practices for sustainability.

The complexity of accounting for climate zones makes it hard to adapt certifications standards for an international context. To complicate matters, climate zones are constantly changing and moving. The most accurate and most frequently used climate classification system is the Köppen-Geiger Climate Classification, formerly the Köppen Climate Classification. First introduced in 1961 by Wladimir Köppen, a Russian-German climatologist, the classification later involved German climatologist Rudolf Geiger as a collaborator. In Figurer 1.17. 'Köppen-Geiger Climate Classification 2013' we can see the world divided into 26 different climate zones.

[27] Petr Hajek, "Complex Methods for Life Cycle Analysis (LCA) and Life Cycle Cost (LCC) Assessments, accessed August 2015, http://www.josre.org/wp-content/uploads/2012/09/Sustainable_Rating_Tools-JOSRE_v1-11.pdf.

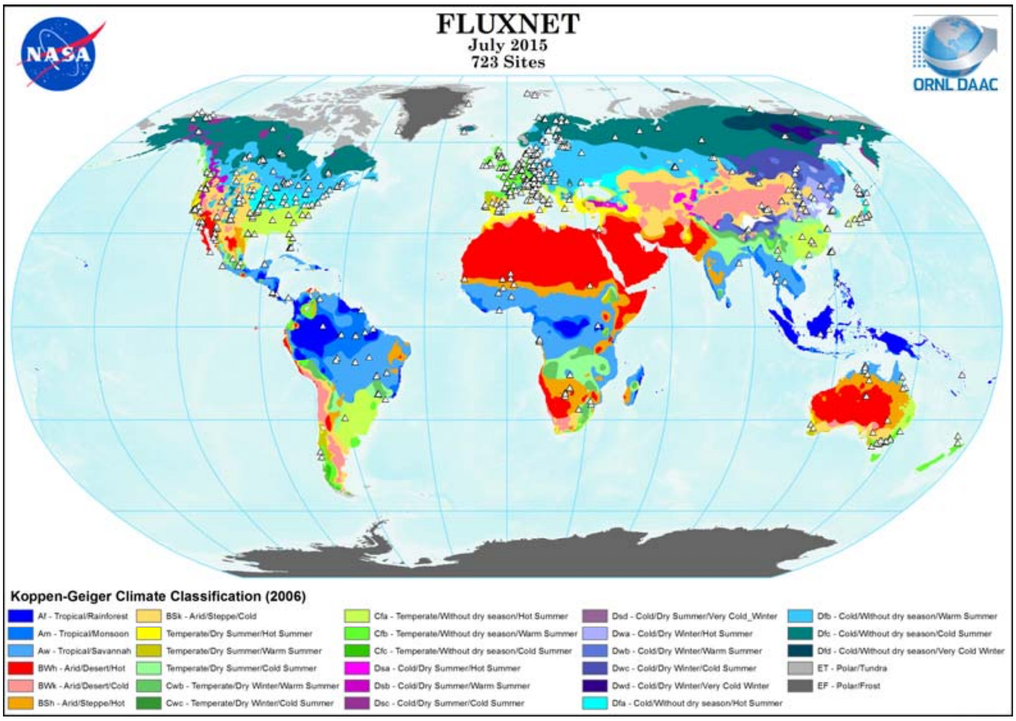


**Figure 1.17. Köppen-Geiger Climate Classification 2013**[28]

Now we can understand why it might be hard to find a global standard for buildings. Different political, geographical, social, demographic, and economic situations in various countries add to the difficulty, making it almost impossible to develop one standard. Furthermore, each country has key areas to focus on in controlling climate change or designing sustainably, and every country has a different historical legacy.

In spite of these problems in developing globally useful or accepted green building standards, a few certifications stand out amid the field. They do so for reasons of history, innovation, and dissemination.

[28] NASA & FLUXNET; Sites and Climate (Koppen-Geiger Classification); access 01.September 2015, http://fluxnet.ornl.gov/maps-graphics

# 2. Methodology

The building sector is the world's biggest $CO_2$ emitter. Climate change, global $CO_2$ emissions, and changes in global demographics necessitate an investigation of green building standards. Following the latest scientific findings, green building standards have created numerous different rating systems, which may make it difficult for architects, engineers, investors, and developers to select the most suitable one for their project. This thesis consists of five main parts. The first gives a brief introduction to the motivation for this research. It focuses on global, political, and demographic change, and on energy consumption in the building sector (see chapter 1, 'Introduction'). The second part considers existing green building standards and their history (see chapter 3, 'Overview and analysis of green building standards'). Part three focuses on four selected green building standards and analyses them to prepare for identifying, in the fourth part, the key differences between four specific standards: LEED, DGNB, ÖGNB, and GBEL (see chapter 4, "Overview and Analysis of Selected Green Building Standards"). By making a comparison between these standards in which the criteria are mapped onto new core categories that are the same for each standard, it is possible to compare the standards and highlight their key differences (see chapter 5, 'Key Diversity of the selected green building standards'). Each standard has different categories and criteria, and the differences are not merely of name but also of content. As a result, it is necessary to develop a set of new core categories before assessing each standard. This makes it possible to compare them on the same level (see subchapter 5.4, 'Criterial differences'). The thesis also develops a common point system based on the new core categories, which allows for demonstration of how the standards weigh the different criteria (see subchapter 5.5, 'Differences in weighting of Criteria'). The new point system is based on the existing ones, which have separate weighting for different criterias demonstrating the focus of each standard. Since the new evaluation method involves an equal amount of points in each standard, it is possible to evaluate the existing total performance against a new index that highlights which standards are the hardest (and easiest) to achieve certification under.

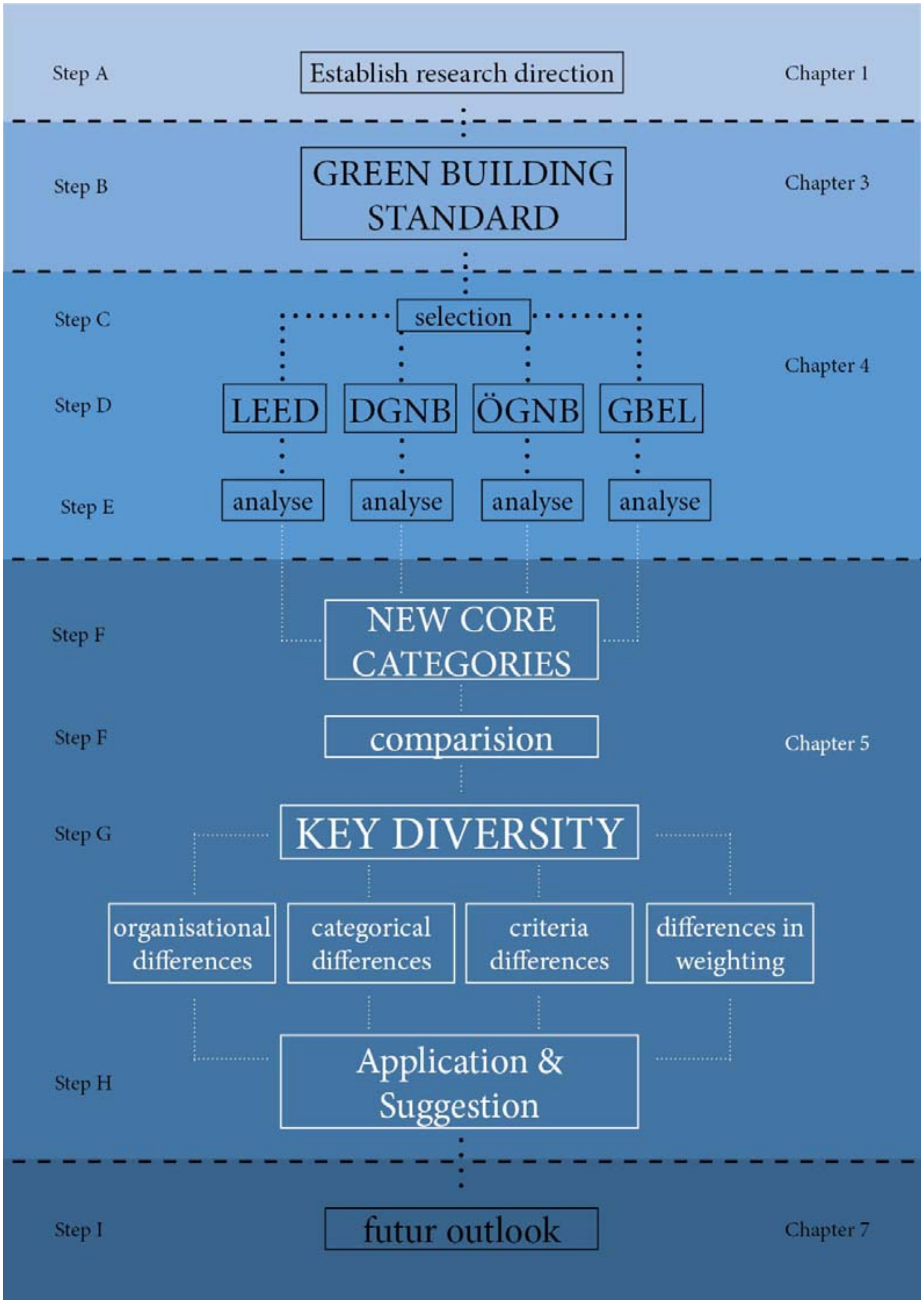


**Figure 2.1. Methodology.**

# 3. Overview and analysis of green building standards

Here I will give a brief overview of all the most common green building certification standards, but will focus on four: DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) from Germany; LEED (Leadership in Energy and Environmental Design) from the United States, Three Star from China, and OGNB (Österreichische Gesellschaft für Nachhaltiges Bauen) from Austria.

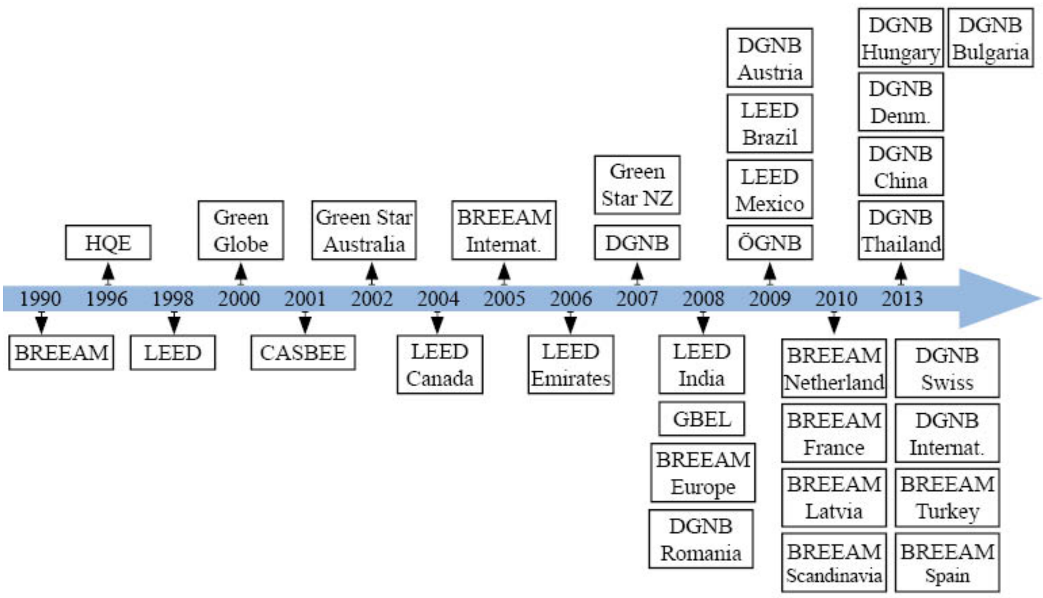


**Figure 3.1. Timelines of most widely known assessment methods**[29]

[29] Thilo Ebert, Nathalie Eßig Gerd, Hauser, Zertifizierungssysteme für Gebäude; Institut für Internationale Architektur-Dokumentation; 2014München

## 3.1 Evolution of green building standards

I will undertake the overview chronologically, starting with the oldest green building certification, BREEAM. Based on this standard from England, France (HQE), Canada (Green Globe), and the United States (LEED) started to develop their own green building standards.

The GB Tool (Green Building Challenge Assessment Framework) is a global standard for environmental assessment developed by more than 20 different national teams, under the auspices of the GBC (Green Building Challenge). GB Tool is an application that can comprehensively rate the performance of a building.[30]

After the creation of HQE, LEED, and Green Globe, which are building assessment systems, and the GB Tool, which is a building-performance simulation system, those systems worked in cooperation with each other. Development of the ratings systems CASBEE (Japan) and Green Star (Australia) rounded out the first generation of green building ratings systems.

The following standards examined in detail belong to the second generation of certified standards. These standards include social and economic criteria and emphasizes the whole life cycle of a project.

[30] Nils K. Larrson and Raymond J. Cole, Green Building Challenge: The Development of an Idea, Building Research and Information, Vol 29 (5)(2001).

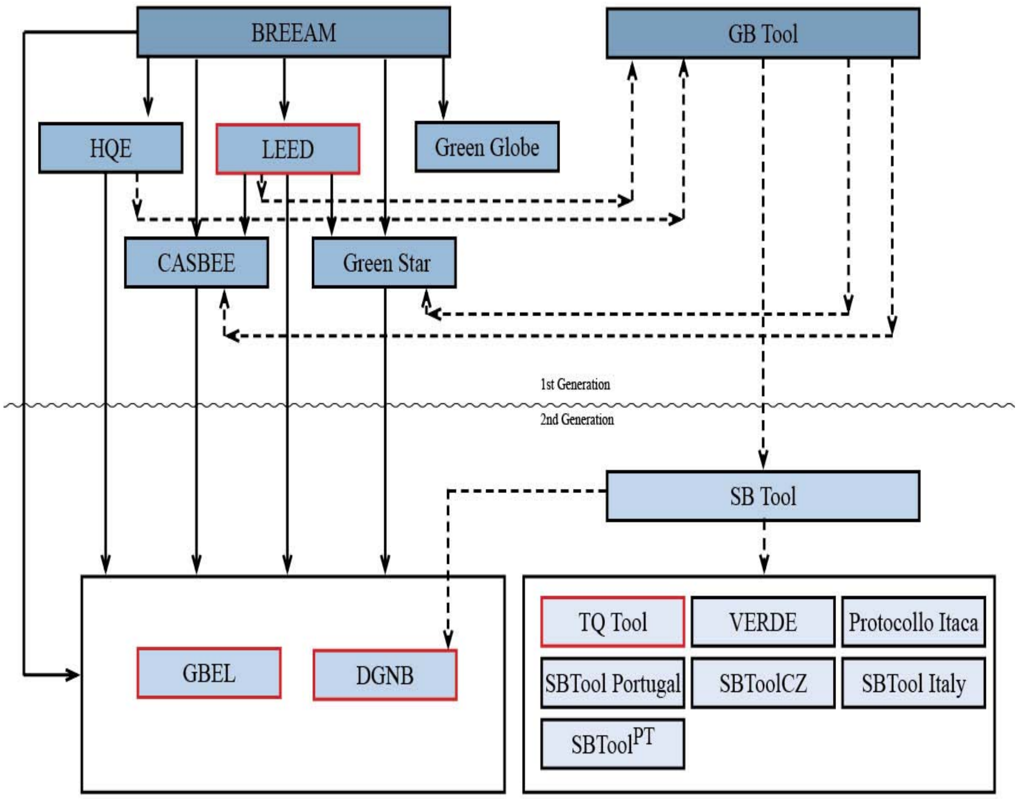


**Figure 3.2. Representation of international assessment methods' dependence on each other**[31]

[31] Zertifizierungssysteme für Gebäude 2014 Institut für Internationale Architektur-Dokumentation Thilo Ebert, Nathalie Eßig Gerd, Hauser

## 3.2 BREEAM (United Kingdom)

**Figure 3.3. BREEAM logo.**

The first green building certificate was created in 1988 and launched in 1990. It was developed by the Building Research Establishment (BRE) in the UK, and is called the Environmental Assessment Method (EAM): together these initialises become the acronym BREEAM. The BRE was founded in 1921. Once a government agency, it is now a private, non-governmental organisation, and its certification system "is the world's longest established method of assessing, rating, and certifying the sustainability of buildings.[32]. BREEAM also provides information about sustainability to the real-estate industry.

BREEAM is a set of standards and certifications that mandate and certify sustainable value in the building environment. Achieving a standard involves meeting what are in many cases very detailed criteria. These criteria are in turn underpinned by a set of principles, which are:

- sustainable solutions
- provide a framework
- based on sound science
- supports change
- delivers value to the occupants

The triple bottom line of BREEAM covers social, economic, and environmental impacts and sustainability. The central idea is to develop a building project that will work in the long term.

Economic sustainability entails making a building cost-effective to build and maintain, now and in the future. Sustainable buildings are low-risk assets that returning increasingly higher value. Social sustainability means making a healthy building that meets its occupants' needs and allows them to flourish. Environmental sustainability means making sure that the building is sensitive to and protects the earth's naturally limited resources and its biodiversity.

[32] Wikipedia Contributors, "BREEAM," *Wikipedia, The Free Encyclopedia,* accessed 31 August 2015, https://en.wikipedia.org/w/index.php?title=BREEAM &oldid=666714156.

BREEAM is a rigorous, criteria-based assessment system:

> BREEAM assessments are based on a scoring system carried out against nine criteria. … Each of the criteria is scored and then multiplied by a weighting. There are minimum thresholds that must be achieved, and additions can be made for particular innovations. The resulting overall score is translated into the BREEAM rating.[33]

Through a third-party verification process, the BREEAM mark provides clients with a clear statement about the quality of the building and its environmental performance. This statement comes in a form of a certified BREEAM rating. There are five rating levels: pass, good, very good, excellent, and outstanding. Each represents a progressively better standard of performance, and the pass rating is broadly equivalent to the performance that marginally exceeds the base level. The excellent and outstanding levels represent performance in the top 10% of buildings.

Buildings are assessed in the areas of management, energy, health and wellbeing, transport, water, material waste, land use, ecology, and pollution. These areas apply to all five building categories recognised by BREEAM: new construction, international new construction, in-use, refurbishment, and communities.

The BREEAM scheme allows assessment of a building's sustainability performance at any stage of its life, from the planning phase to operation of an existing asset.

The first BREEAM certification standards were valid only for the UK. In 2005, BREEAM International was introduced. Three years later, BREEAM Europe followed, and in 2010 BREEAM developed certification standards for several more countries and regions, including Turkey, Spain, Scandinavia, Latvia, France, the Netherlands, Austria, and Germany—all of which were adapted to local conditions.

BREEAM has already certified over 425,000 buildings. Additionally, 2 million projects are registered for assessment, in over 60 countries worldwide.

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[33] BREEAM, "BREEAM – Designing Buildings Wiki," last edited 30 June 2015, http://www.designingbuildings.co.uk/wiki/BREEAM.

Fees to get a BREEAM certificate vary depending on the system and building type involved, though there is no differentiation based on external dimensions or total floor space. The registration fee and certification fee are around €980–1300 for the design and procurement phase, €430–580 for a post-construction review, €1400–1900 for post-construction assessment, and around €100 for assessment of management and operation.

## 3.3 CASBEE (Japan)

**Figure 3.4. CASBEE logo.**

CASBEE is an acronym for Comprehensive Assessment System for Built Environment Efficiency and is a green building rating tool used to analyse building performance at several stages in the building life cycle. Introduced to the public in 2001, it was developed by the following groups in Japan:

- the Ministry of Land
- the Ministry of Transport and Tourism
- the Japan GreenBuild Council (JaGBC)
- the Japan Sustainable Building Consortium (JSBC)
- the Institute for Building Environment and Energy Conservation (IBEC)

CASBEE has the following policies:

1. The system should be structured to award high assessments to superior buildings, thereby **enhancing incentives** to designers and others.
2. The assessment system should be as **simple** as possible
3. The system should be applicable to buildings in a **wide range** of building types
4. The system should take into consideration issues and problems peculiar to **Japan and Asia**.[34]

Today, CASBEE uses four different evaluation methods, depending on the building's place in the life cycle:

- pre-design
- new construction
- existing building
- renovation

These methods are supplemented with five tools for different applications:

- heat island
- urban development
- urban area and buildings
- home (detached house)
- property appraisal

[34] Athulya Aby, et al., "CASBEE Certification, Japan", 21 September 2014, http://www.de.slideshare.net/athulyaaby/casbee-certification.

When rating and evaluating a building, the BEE (building environment efficiency) quotient is important. BEE is derived from assessments of Q (quality) and L (load).

Q (built environment quality and performance) evaluates "improvement in living amenity for the building users, within the hypothetical enclosed space (the private property)." Q is further divided into Q1 (indoor environment), Q2 (quality of service), and Q3 (outdoor environment on site).[35]

L (built environment load) evaluates "negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)." L is further divided into L1 (energy), L2 (resources and materials), and L3 (off-site environment). Q and L are rated on a scale of 0–100.

The higher the Q figure is, the lower must the L figure be to achieve a more sustainable building and thus a rating certificate

The assessment system offers five ranks, S (excellent), A (extremely good), B+ (good), B− (rather poor), and C (poor). A building rated A or S is deemed excellent and sustainable.

There are at present no plans to further develop CASBEE into an international rating system, or even one suitable for use in another country. This makes it unattractive for architects and developers outside Japan and Asia. All standards and norms it refers to are customised for the Japanese market, with the exception of thermal comfort assessment, which is based on the US standards ASHRAE 55 and POE-O.Certification fees for CASBEE range from around ¥400,000 to ¥1,000,000, according to building size and type. Fees for CASBEE-accredited assessors and consulting agencies vary.[36] There are over 450 CASBEE-certified buildings.[37]

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35 Japan GreenBuild Council and Japan Sustainable Building Consortium, "The Assessment Method Employed by CASBEE," accessed 8 August 2015, ibec.or.jp/CASBEE/english/methodE.htm.
36 International Federation of Consulting Engineers, "Rating & Certification Tool: CASBEE," accessed 8 August 2015, fidic.org/sites/default/files/R%26C%20CASBEE%20-%20final%20v2.pdf
37 Japan GreenBuild Council and Japan Sustainable Building Consortium, "Dissemination of CASBEE in Japan," ibec.or.jp/CASBEE/english/statistics.htm.

## 3.4 Green Star (Australia)

**Figure 3.5. green star logo.**

Australia's green building certification system, Green Star, is administered by "the Green Building Council of Australia (GBCA) … established in 2002 as a not for profit organization to develop a sustainable property industry in Australia."[38]

The Green Star rating tool was launched in 2003, and is also applied in New Zealand and South Africa. It is based on the British certification system, BREEAM, and the American certification system, LEED.

All tools for Green Star certification are free for architects, planners, investors, and property owners. The system measures the environmental impact of buildings and communities, and certifies accordingly. It evaluates a range of areas, including materials, energy, water, transport, land use and ecology, innovation, emissions, indoor environment quality, and management.

The Green Star rating scale goes from 1 star to 6 stars in each area.

A 4-star rating means the building has achieved best-practice standards. A 5-star rating signifies Australian excellence, and a 6-star rating (the highest) represents world leadership.

In the categories of design and build, interiors, and communities, the scale goes from 4-star to 6-star.

Green Star–rated apartments in Melbourne have been shown to reduce energy consumption by 65%, compared to similar non-certified apartments. This slashes around €200 per quarter off the average resident's electricity bill.

A Green Star building evaluation is carried out in a series of steps:

- qualification
- registration
- submission
- assessment 1

[38] Green Building Council of Australia, "About," accessed 8 August 2015, gbca.org.au/about/.

- assessment 2
- certification

There are eight different areas of application, though primary the Green Star system is used for offices and commercial buildings:

- Green Star – Office Design
- Green Star – Office as Built
- Green Star – Office Interiors
- Green Star – Office Existing
- Green Star – Education
- Green Star – Healthcare
- Green Star – Shopping Centre Design
- Green Star – Multi Unit Residential

The total number of Green Star–rated buildings is over 570, accounting for a total area of 7,200,000m²

# 4. Overview and analysis of selected green building standards

## 4.1 LEED (Leadership in Energy & Environmental Design)

The United States Green Building Council (USGBC) was founded in 1993 as a non-profit organisation. Today the USGBC has more than 15,000 member organisations. The first LEED pilot program, LEED version 1.0, was launched in August 1998. After extensive modification, the LEED green building rating system version 2.0 was launched in March 2000. This system is called the Green Building Rating System for New Commercial Construction and Major Renovations (LEED NC).

**Figure 4.1. LEED logo.**

In 2007, Green Business Certification Inc. (GBCI) was established as a separately incorporated identity with the support of the USGBC.

Since Version 1.0, LEED has undergone many updates, including LEED 2009 and, for industries at the cutting edge, LEED v4, which was launched in November 2013. LEED 2009 will be open for project registration until June 2015. Projects do not yet have to be registered under v4. All projects registered under LEED 2009 will have until June 2021 to establish their final documentation and be certified.

Previous versions of LEED have already had a significant impact on the environment. According to a USGBC study,[39] LEED projects divert over 80 million tons of waste

[39] Watson, Rob. Green Building and Market Impact Report – 2011. Accessed Nov. 15, 2011 via http://www.greenbiz.com/sites/all/themes/greenbiz/doc/GBMIR_2011.pdf

from landfills every year. A review of 195 LEED-certified projects found that those buildings are in the eleventh percentile in the US in terms of energy usage. They have an energy source score of 89 out of 100 points, and a 57% lower source energy use intensity than the national average.

LEED v4 is the next step in LEED's continued development. It encourages interdisciplinary project teams to use an integrated project delivery process by combining mandatory and optional strategies in a framework. It promotes action in six key areas:

- location and transport
- sustainable sites
- water efficiency
- energy and atmosphere
- material and resources
- indoor environment quality

There are also two bonus credit categories: *innovation in design*, for which projects can earn additional points for exemplary performance and innovation; and *regional priority*, for which projects can gain extra credit by placing importance on local environmental needs.

Under each of this six credit categories are collections of mandatory and optional strategies. Mandatory strategies are prerequisites for entering the system, while optional strategies earn projects credits. Each prerequisite, and each credit, has a stated intent and a set of requirements.


**Figure 4.2. LEED v4 rating systems categories**[40]

[40] US Green Building Council, "LEED," accessed 21 August 2015, http://www.usgbc.org/LEED/#credits

Prerequisites represent key criteria that define green building performance, and projects must comply with prerequisites to gain LEED certification. Compliance with all prerequisites must be documented, as must the project's credits. A project will be given a score between 40 and 100 points based on its credits. Higher levels of achievement are awarded higher levels of certification: 40 to 49 points is LEED-certified, 50 to 59 points is LEED silver, 60 to 79 points is LEED gold, and over 80 points is LEED platinum.

LEED v4 system goals include seven impact categories:

- reduce contribution to global climate change
- enhance individual human health
- protect and restore water resources
- protect and enhance biodiversity and ecosystem services
- promote sustainable and regenerative material cycles
- build a green economy
- enhance community quality of life

In previous LEED systems, the goal was to do less harm. LEED now attempts to do more good. Its goals have been expanded to encompass people, the planet, and profit.

USGBC uses three associated factors to measure credit outcomes in a given impact category: relative efficacy, benefit duration, and controllability of effect. Relative efficacy measures how the credit outcome is associated with the goal in question; benefit duration refers to how long the benefits of the credit outcome can be expected to last; and controllability of effect considers who is likely to benefit from the credit outcome. Assessing these three parameters allows USGBC to measure outcomes against its system goals.

By using this process to assign the highest point values to credits that will have the greatest impact, LEED v4 provides project teams with the most efficient map of environmental benefit. By prioritising the credits worth the most points, teams will be led to apply strategies that result in higher performance buildings—ideally, LEED platinum.

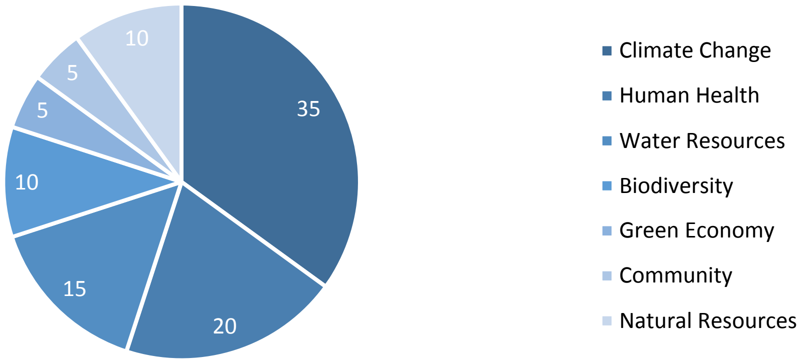



**Figure 4.3. Weighting of LEED v4**[41]

In short, LEED makes it economically irrational to ignore energy-efficiency categories. By appealing to this economic rationality, LEED is trying to prioritise the right factors.

The following graphic shows the cumulative activity count by year of LEED, demonstrating tremendous growth since 2000. LEED is the most popular and widely used green building rating system globally. There are currently more than 72,500 LEED building projects, located in over 150 countries and territories.[42] The number of LEED registered projects has doubled since 2010.

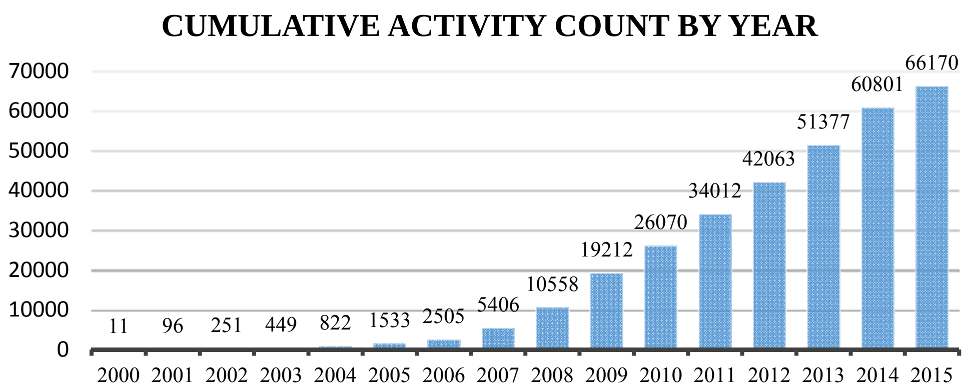



**Figure 4.4. Cumulative activity count by year (as of June 2015)**

[41] Brendan Owens, Chrissy Macken, Adam Rohloff, and Heather Rosenberg, "LEED v4 Impact Category and Point Allocation Development Process" (2015), http://www.studio4llc.com/wp-content/uploads/2011/01/LEED-v4-Impact-Category-and-Point-Allocation-Process_Overview_0.pdf.

[42] US Green Building Council, "Green Building Facts," accessed 31 August 2015, http://www.usgbc.org/articles/green-building-facts.

The countries with the most LEED registered and certified projects are:

- the United States
- Canada
- China
- India
- Brazil
- South Korea
- Germany
- Taiwan
- United Arab Emirates
- Turkey
- Sweden

As of August 2015, approximately 43% of all square footage pursuing LEED certification was outside the US. Commercial projects of 83% of firms in Brazil are planned to be green, as are 73% in the United Arab Emirates.[43]

LEED v4 supports twenty-one different building types, making LEED more appropriate for more projects than other standards.

**There are five main rating systems:**

- BD+C = building design and construction
- ID+C = interior design and construction
- O+M = building operations and maintenance
- ND = neighbourhood development
- Homes

Each of those five has a number of subgroups:

[43] McGraw-Hill Construction, "World Green Buildings Study," accessed 29 November 2012, http://www.usgbc.org/articles/green-building-facts.

**Green Building Design & Construction**

- LEED for New Construction
- LEED for Core & Shell
- LEED for Schools
- LEED for Retail: New Construction and Major Renovations
- LEED for Data Centers
- LEED for Warehouses & Distribution Centers
- LEED for Hospitality
- LEED for Healthcare

**Green Interior Design & Construction**

- LEED for Commercial Interiors
- LEED for Retail: Commercial Interiors
- LEED for Hospitality

**Green Building Operations & Maintenance**

- LEED for Existing Building: Operations & Maintenance

**Green Neighborhood Development**

- LEED for Neighborhood Development

**Green Home Design & Construction**

- LEED for Homes

The latest numbers for LEED certification were published on 9 June 2015, reporting worldwide **LEED activity in May 2015[44].**

| Rating system | Total units certified | Single family units certified | Multifamily units certified | Total square footage certified |
|---|---|---|---|---|
| Homes | 1,028 | 300 | 728 | 1.6 million |

**Table 4.1. LEED-certified multi-residential units.**

[44] USGBC, "LEED Certification Update: May 2015", accessed 22 August 2015, http://www.usgbc.org/articles/leed-certification-update-may-2015

| Certification Level | Projects Certified | Square Footage Certified |
|---|---|---|
| Certified | 63 | 7.3 million |
| Silver | 123 | 13.7 million |
| Gold | 132 | 35.9 million |
| Platinum | 30 | 8.5 million |

**Table 4.2. LEED projects certified by level, number, and total square footage.**

| Rating System | Projects Certified | Square Footage Certified |
|---|---|---|
| New Construction | 166 | 19.3 million |
| Commercial Interiors | 39 | 3.0 million |
| Core and Shell | 45 | 16.2 million |
| Existing Buildings | 58 | 25.6 million |
| Retail – Commercial Interiors | 21 | 261,077 |
| Retails – New Construction | 6 | 35,718 |
| Schools – New Construction | 13 | 1.1 million |
| Total | 348 | 65.5 million |

**Table 4.3. LEED projects certified by system, number, and total square footage.**

| Country | Projects certified | Square footage certified |
|---|---|---|
| Australia | 1 | 131,115 |
| Austria | 1 | 282,000 |
| Bangladesh | 1 | 184,573 |
| Belgium | 1 | 137,944 |
| Brazil | 4 | 2.7 million |
| Cambodia | 1 | 235,730 |
| Canada | 1 | 420,000 |
| China | 18 | 5.6 million |
| Colombia | 1 | 59,869 |
| Costa Rica | 1 | 16,355 |
| Czech Republic | 1 | 85,015 |
| Finland | 4 | 1.4 million |
| France | 2 | 426,314 |
| Germany | 4 | 806,177 |
| Hungary | 2 | 227,635 |
| India | 4 | 5.1 million |
| Indonesia | 1 | 46,543 |
| Italy | 6 | 992,775 |
| Kenya | 1 | 218,175 |

| | | |
|---|---|---|
| Mexico | 4 | 1.5 million |
| Morocco | 1 | 202,537 |
| Panama | 1 | 1,874 |
| Peru | 1 | 99,756 |
| Philippines | 2 | 100,806 |
| Poland | 1 | 34,059 |
| Qatar | 1 | 217,807 |
| Republic of Korea | 4 | 420,739 |
| Russian Federation | 1 | 451,212 |
| Spain | 2 | 173,825 |
| Sri Lanka | 2 | 147,275 |
| Taiwan | 1 | 1.9 million |
| Turkey | 5 | 3.8 million |
| United Arab Emirates | 1 | 34,743 |
| United Kingdom | 1 | 1,411 |
| United States | 261 | 36.7 million |

**Table 4.4. Projects certified by country, number, and square footage.**

LEED v4 addresses the unique needs of particular space types, whether they are driven by the occupations or facilities that the space serves, by regulatory requirement, or by unique research functions. LEED's rating systems now take into account each sector's needs, and the rating system applies more evenly across different sectors. Because the credits are more similar across different project types in LEED v4 than in previous versions of the standards, project teams can apply the knowledge they gained from one project type and apply it to another.

### Certification process

The LEED v4 certification process begins with registration. This is followed by applications, a preliminary review, preliminary review response, a final review, a possible appeal, and appeal review. Final certification occurs after the project has been built. The following graphic shows the process in more detail:

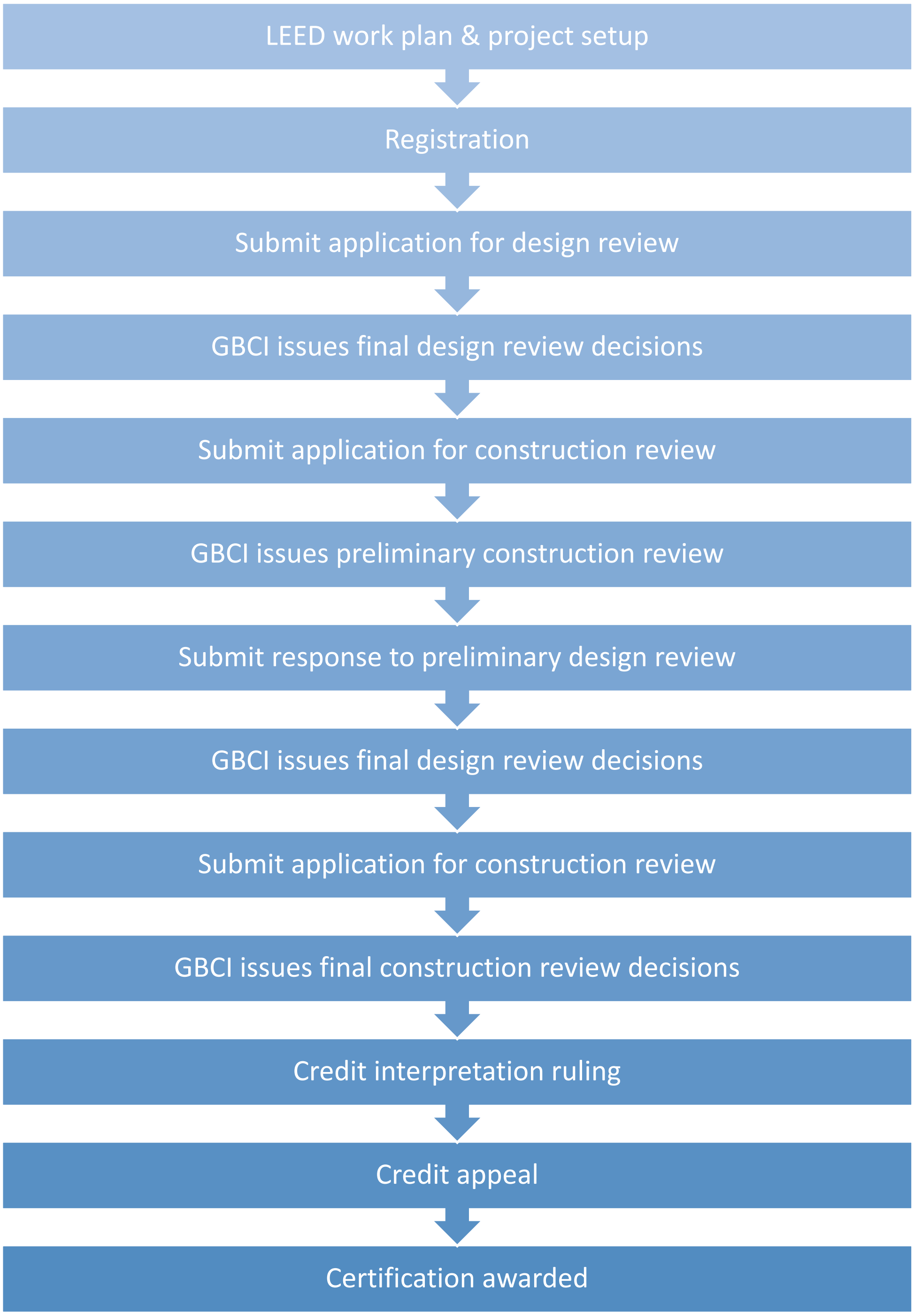



**Figure 4.5. LEED v4 process: phases of certification**[45]

[45] Based on greenprep.files.wordpress.com/2010/06/phasesofcertification_thumb1.jpg ?w=730&h=371, access 05.August 2015

The process begins when the owner selects the rating system and registers the project. The project is then designed to meet the prerequisites and the credits the team has chosen to pursue. After the documentation has been submitted for certification, the project goes through preliminary and final reviews. The preliminary review gives technical advice on credits that require additional work to achieve, and the final review contains the final project score and the building's certification level. The decision can be appealed if a team believes additional consideration is warranted.

### Registration and certification fees

LEED's registration and certification fees are determined by a complex process. Registration fees are at a flat rate, and must be paid at the time of the registration. Certification fees, however, are determined by the project's rating system and square footage. Discounts are available if the owner or project administrator has owned or administered previous LEED projects.[46]

The following tables show the registration and certification fees for LEED

| **Fee Type** | **Non-members** | **Silver, Gold and Platinum Members** | **Member Savings** |
|---|---|---|---|
| **Registration** | $1,200 | $900 | $300 |
| **Pre-certification Review (optional, LEED CS only)** | | | |
| **Flat fee (per building)** | $4,250 | $3,250 | $1,000 |
| **Expedited review (10–12 business days, available based on GBCI review capacity)** | $5,000 | | |
| **Combined Review: Design & Construction** | | | |
| **Project gross floor area (excluding parking): less than 50,000sq. ft** | $2,750 | $2,250 | $500 |

[46] USGBC, "LEED Certification Fees," accessed 22 August 2015, http://www.usgbc.org/cert-guide/fees. You will also find information on fees for further LEED schemes at this address.

| | | | |
|---|---|---|---|
| **Project gross floor area (excluding parking): 50,000–500,000sq. ft** | $0.055/sq. ft. | $0.045/sq. ft. | $0.01/sq. ft. |
| **Project gross floor area (excluding parking): more than 500,000sq. ft** | $27,500 | $22,500 | $5,000 |
| **Expedited review (10–12 business days, available based on GBCI review capacity)** | $10,000+ | | |
| **Split Review: Design** | | | |
| **Project gross floor area (excluding parking): less than 50,000sq. ft** | $2,250 | $2,000 | $250 |
| **Project gross floor area (excluding parking): 50,000-500,000sq. ft** | $0.045/ sq. ft. | $0.04/sq. ft. | $0.005/sq. ft. |
| **Project gross area (excluding parking): more than 500,000sq. ft** | $22,500 | $20,000 | $2,500 |
| **Expedited review (10–12 business days, available based on GBCI review capacity)** | $5,000 | | |
| **Split Review: Construction** | | | |
| **Project gross floor area (excluding parking): less than 50,000sq. ft** | $750 | $500 | $250 |
| **Project gross floor area (excluding parking): 50,000–500,000sq. ft** | $0.015/sq. ft. | $0.01/sq. ft. | $0.005/sq. ft. |
| **Project gross floor area (excluding parking): more than 500,000sq. ft** | $7,500 | $5,000 | $2,500 |
| **Expedited review (10–12 business days, available based on GBCI review capacity)** | $5,000 | | |
| **Appeals** | | | |
| **Complex credits** | $800/credit | | |
| **All other credits** | $500/credit | | |
| **Expedited review (10–12 business days, available based on GBCI review capacity)** | $500/credit | | |
| **Formal inquiries** | | | |
| **Project CIRs** | $220/credit | | |

**Table 4.5. LEED building design and construction fees**

## 4.2. DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen)

The German Sustainable Building Council, or DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen), was founded on 25 June 2007 by sixteen organisations:

**Figure 4.6. DGNB logo.**

- 3A Composites GmbH
- Behnisch Architekten
- CalCon Holding GmbH
- DU Diederichs Projektmanagement AG & Co. KG
- Eternit AG
- Fachhochschule für Technik und Wirtschaft Berlin
- Five Winds International
- GfÖB
- Hines Immobilien GmbH
- Ingenieurbüro Trinius GmbH
- L2 Architekten
- nora systems GmbH
- PE International AG
- sauerbruch hutton GmbH
- Universität Stuttgart
- WSGreenTechnologies GmbH

Those sixteen initiators came from university bodies, real-estate companies, and the construction sector. The German Federal Ministry of Transport, Building and Urban Development was also involved in the development of the certification system.

The first certificates were issued in 2009. That year saw forty-seven projects certified under the system, forty-six in Germany and one in Austria.

DGNB has over 1,200 members worldwide, including architects, planners, the construction industry, investors, and scientists. There are 1,172 pre-certified and certified projects in twenty different countries. Including registered projects, the system involves 1,281 projects, with a total of 56.2 million sq. ft.

| Country | Total projects | Gold | Silver | Bronze | Registered |
|---|---|---|---|---|---|
| **Bulgaria** | 5 | 5 | 0 | 0 | 0 |
| **China** | 4 | 3 | 0 | 0 | 1 |
| **Denmark** | 25 | 1 | 21 | 2 | 1 |
| **Germany** | 1041 | 30 | 383 | 215 | 413 |
| **Greece** | 1 | 0 | 0 | 0 | 1 |
| **Canada** | 1 | 0 | 1 | 0 | 0 |
| **Luxembourg** | 14 | 8 | 2 | 0 | 4 |
| **Netherlands** | 1 | 0 | 1 | 0 | 0 |
| **Austria** | 55 | 24 | 23 | 5 | 3 |
| **Poland** | 1 | 0 | 0 | 0 | 1 |
| **Romania** | 3 | 2 | 1 | 0 | 0 |
| **Russia** | 2 | 2 | 0 | 0 | 0 |
| **Switzerland** | 7 | 6 | 1 | 0 | 0 |
| **Slovakia** | 1 | 1 | 0 | 0 | 0 |
| **Spain** | 2 | 0 | 1 | 1 | 0 |
| **Thailand** | 1 | 1 | 0 | 0 | 0 |
| **Czech Republic** | 1 | 1 | 0 | 0 | 0 |
| **Turkey** | 1 | 1 | 0 | 0 | 0 |
| **Ukraine** | 3 | 0 | 0 | 0 | 3 |
| **Hungary** | 3 | 1 | 1 | 1 | 0 |

**Table 4.6. DGNB projects worldwide**[47]

[47] "DGNB pre-certified and certified projects," accessed 21 August 2015, http://www.dgnb-system.de /en/projects/index.php?filter_Freitextsuche=&filter_Jahr=&filter_Land= &filter_Zer

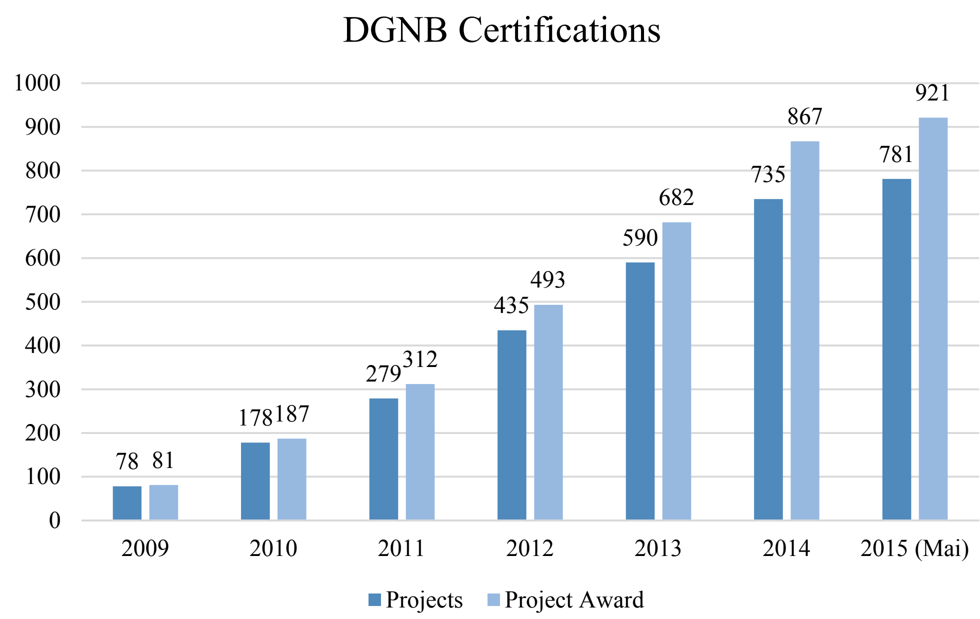



**Figure 4.7. DGNB certifications timeline**[48]

DGNB focuses on sustainability, based on six pillars: environmental quality, economic quality, sociocultural and functional quality, technical quality, process quality and site quality. Looking at these criteria, we can see that DGNB is a second-generation green building certification system because it has implement a social and an economy criteria. It focuses on the entire performance of buildings or districts, rather than on individual measures and criteria. Projects can achieve three different levels of certification, based on about forty criteria (see ApendixII 'Criteria catalogue DGNB Core 14'). There are twenty-two categories for existing buildings, fifteen for new buildings, and three for urban districts, as listed in Table 4.8 'DGNB Core catalogue' below.

[48] DGNB ´System, DGNB certificates; access 01 September 2015 http://www.dgnb-system.de/en/projects/index.php?filter_Freitextsuche=&filter_Jahr=&filter_Land=&filter_Zer


**Figure 4.8. The DGNB concept includes six subject fields.**

There are four certification levels in DGNB. Existing buildings can be certified, but without an award. To be certified bronze, new buildings must reach at least 50% of the total performance and at least 35% in each core criteria. For silver, the project must have a minimum score of 65% on total performance and 50% minimum in each core sector. For the highest certification level, gold, a project must reach at least 80% in total performance and 65% in each of the core criteria.[49]

[49] "Gold. Silver. Bronze. The Assessment." accessed 21 August 2015, http://www.dgnb-system.de/ en/system/gold-silver-bronze/

| Existing buildings | New buildings | Urban districts |
|---|---|---|
| Office and administrative buildings | Office and administrative buildings including modernisation | Trading estates |
| Retail buildings | Complete renovation of office and administrative buildings | Industrial estates |
| Industrial buildings | Tenant fit-out, office and administrative buildings | Urban districts |
| Residential buildings | Tenant fit-out, retail buildings | |
| | Education facilities | |
| | Office and administrative buildings | |
| | Healthcare buildings | |
| | Retail buildings | |
| | Hotels | |
| | Industrial buildings | |
| | Small residential buildings | |
| | Laboratory buildings | |
| | Mixed-used buildings | |
| | Assembly buildings | |
| | Residential buildings | |

**Table 4.7. DGNB Categories**

The criteria for buildings and for urban districts are shown in Figure 4.9.'DGNB Core Catalogue Criteria' There are fifteen criteria for New Construction, twenty-two for existing Office and Administrative Buildings and, since 2011, forty-five criteria for three different categories of Urban Districts.

| Core Catalogue for Buildings | Core Catalogue for Urban Districts |
|---|---|
| **Environmental quality** | |
| Life cycle assessment | Life cycle assessment |
| Local environmental impact | Water and soil protection |
| Land use | Land use |
| Primary energy demand | Biodiversity and interaction |
| Drinking water demand and wastewater | Consideration of possible environmental impact |
| Environmentally friendly material production | Total primary energy demand and renewable primary energy |
| | Change in city district climate |
| | Energy efficient development structure |
| | Infrastructure with low resource consumption |
| | Groundwater management |
| | Local food production |
| | Water cycle |
| **Economic quality** | |
| Building-related lifecycle costs | Lifecycle costs |
| Value retention | Fiscal effects on municipality |
| Sustainability for third-party use | Value retention |
| | Efficient use of space |
| **Sociocultural and functional quality** | |
| Thermal comfort | Social and functional diversity |
| Indoor air quality | Social and labor infrastructure |
| Acoustic comfort | Objective/subjective security |
| Visual comfort | Quality of open areas in public spaces |
| User influence on building operation | Noise protection |
| Quality of outdoor spaces | Proportion of open areas |
| Safety and security | Handicapped accessibility |
| Design and urban planning quality through competition | Occupancy flexibility and development |
| Efficient use of floor area | Adaptation to urban development plan |
| Suitability for conversation | Urban planning design |
| Public access | Use of existing buildings |
| Cycling convenience | Public art |
| Handicapped accessibility | |
| Integration of public art | |
| Site features | |

**Table 4.8. DGNB Core Catalogue**

| Core Catalogue for Building | Core Catalogue for Urban Districts |
|---|---|
| **Technical Quality** | |
| Fire prevention | IT and communication infrastructure |
| Indoor acoustics and sounds insulation | Energy technology |
| Building envelope quality | Waste management |
| Backup capacity of technical building systems | Rainwater management |
| Ease of cleaning and maintenance | Dismantling, sorting, and recycling of infrastructure |
| Resistance to hail, storms, and flooding | Maintenance, servicing, cleaning |
| Pollution control | Quality of transport systems |
| Noise emission control | Quality of road infrastructure |
| | Quality of public transport infrastructure |
| | Quality of pedestrian infrastructure |
| **Core Catalogue for Building** | **Core Catalogue for Urban Districts** |
| **Process quality** | |
| Comprehensive project definition | Participation |
| Integrated planning | Concepts developed in competitive bids |
| Comprehensive building design | Integrated planning |
| Sustainability aspects in tender phase | Community involvement |
| Documentation for facility management | Controlling |
| Environmental impact of construction Site/construction process | Environmental impact of construction site /construction process |
| Systematic commissioning | Marketing |
| Construction quality assurance/quality control measures | Quality assurance and monitoring |
| **Site Quality** | |
| Site location risks | Integrated as a criterion for assessment |
| Site location conditions | |
| Public image and social conditions | |
| Access to transportation | |
| Access to specific use facilities | |

**Table 4.9. DGNB Core Catalogue Criteria**

The values of the core categories differ. Each of DGNB's main core categories (economic quality, environmental quality, and sociocultural and functional quality) accounts for 22.5% of the certification. Technical quality accounts for another 22.5%. The final 10% is for process quality, including the planning and construction processes which are not quantitatively evaluatable. Site quality is a separate core category, which is not included in the DGNB Gold, Silver or Bronze certifications.

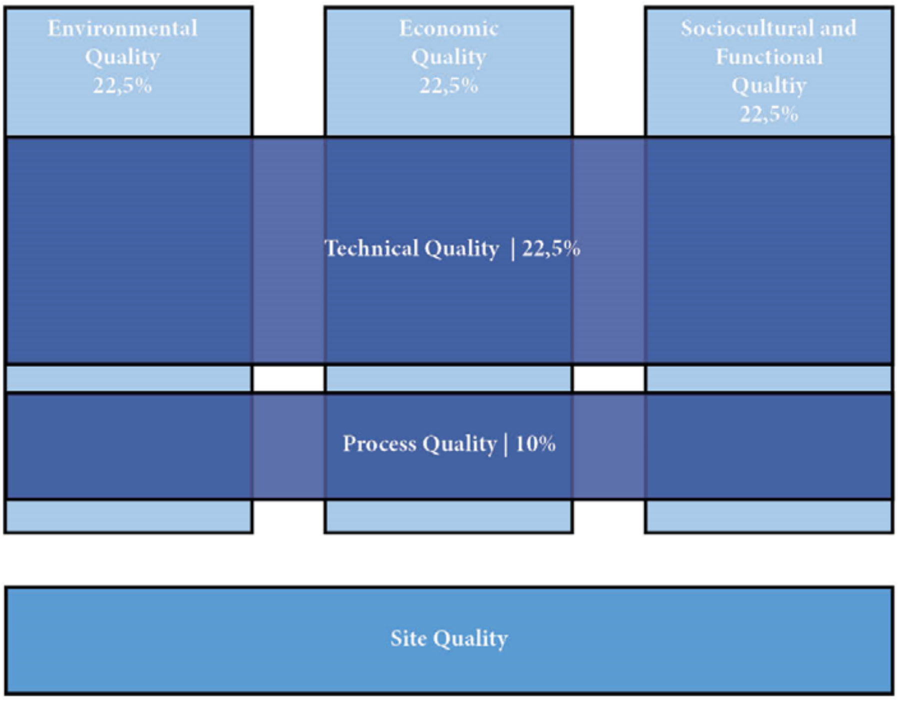



**Figure 4.9. DNGB core categories**

### Certification process

DGNB has both pre-certification and certification processes. Pre-certification deals with planning goals and is issued during the planning phase. Certification proper can occur only after a project has been completed. Any pre-certified project must be certified upon completion.

DGNB certification consists of a number of steps. First, the client finds and commissions a suitable auditor. The auditor supports the client and monitors the process from beginning to end. First, the auditor will sign in the building or project at the relevant DGNB department. The client and DGNB then sign a contract. In the second phase, the auditor gives the client's information and documentation to DGNB. They check everything and regularly consult with the auditor. DGNB sends the audit report to the client, who gives their consent to accept the outcome of the rating and that DGN will publish it. Only then does the DGNB certification committee approve the result and inform the client.

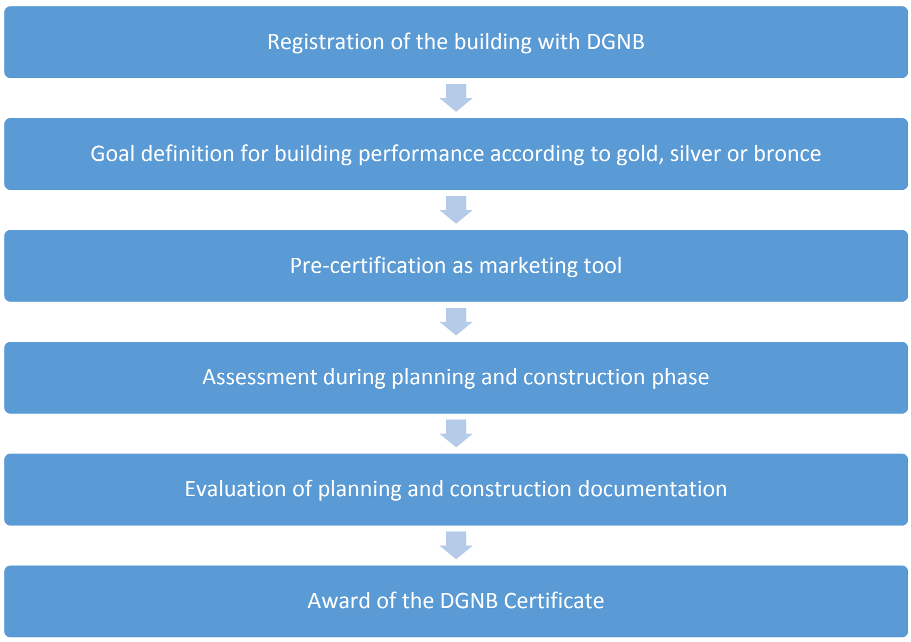



**Figure 4.10. DGNB certification process**[50]

### Certification fees

The certification costs are divided into two parts. The certification fees are fixed costs. They pay for the DGNB certification process, including the first two examinations of the conformity inspection. The fees depend on whether the client is requesting certification or pre-certification, as well as the gross floor space, the scheme selected, and the applicants' DGNB membership status. If the auditor or building owner or

[50] DGNB, the Path of Certification access 01.Spember 2015
http://www.dgnbsystem.de/fileadmin/de/dgnb_system/_system/Certification_Process_700.jpg
? id=36061&time=1406300697

principal insists on further reviews, DGNB will charge an additional €1,000 for pre-certification or €2,000 for certification, for up to ten criteria. For each further criterion, DGNB will charge €250 for pre-certification or €500 for certification. The conformity assessment can only be finalised once all certification fees have been paid. There is a 20% discount on certification fees for projects that take part in a pilot phase.

The client also has to pay additional fees to the auditor. These costs depend on the project. They are agreed upon in a contract between the client and the auditor. So, the total fees depend partly on the auditor.

| | **DGNB members** | | | **DGNB non-members** | | |
|---|---|---|---|---|---|---|
| **Project size (gross floor area in m²)** | < 4,000 | 4,000–80,000 | 80,000–150,000 | <4,000 | 4,000–80,000 | 80,000–150,000 |
| **Pre-certificate** | €2,000 | €2,000 + €0.13/m² | €11,880 | €4,000 | €4,000 + €0.13/m² | €13,880 |
| **Certificate** | €3,000 | €3,000 +€0.33/m² | €28,080 | €6,000 | €6,000 + €0.33/ m² | €31,080 |

**Table 4.10. DGNB Certification fees for the New Office category, version 2014**[51]

All fees listed above exclude value-added tax (VAT), which will be added if applicable. The discount for members applies if the project principal is a DGNB member or partner member. The fees are calculated based on gross floor area (GFA) in accordance with ISO 9836 and DIN 277:2005-02. GFA includes all of the floors above and below ground, including all garages, storage areas, and mechanical rooms. For office buildings with a gross area larger than 150,000m², DGNB will make an individual offer for certification fees.

[51] DGNB –System, Certification fees for New Office, Version 2014, access 01.September 2015 http://www.dgnb-system.de/fileadmin/en/dgnb_system/certification_fees/NOF14-Certificationfees20141124.pdf

## 4.3 ÖGNB: Österreichische Gesellschaft für Nachhaltiges Bauen

**(e.V: ASBC—Austrian Sustainable Building Council)**

**Figure 4.11. ÖGNB logo.**

ÖGNB was founded on 28 February 2009, though the history of the council reaches back to the 1980s. Two institutes that promoted research in sustainable building, the Austrian Institute for Building Biology and Ecology (IBO) and the Austrian Institute for Ecology (ÖÖI) were the foundation for what we know today as ÖGNB. They were joined by the Austrian Energy Agency (AEA), the Energy Institute Vorarlberg, and the Austrian Society for Environment and Technology (OEGUT).

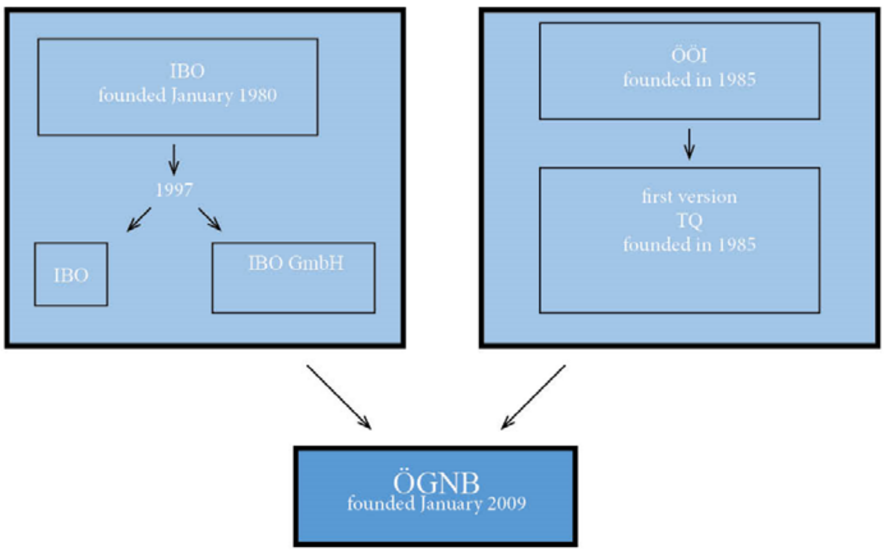



**Figure 4.12. History of ÖGNB.**

ÖÖI represented Austria at the Green Building Challenge, which led to the first version of the Total Quality Building (TQB) rating tool that the ÖGNB uses to certify its projects. IBO developed the IBO Ökopass, a certification specifically for residential buildings. In 2007, IBO and ÖÖI combined these tools as TQB.

ÖGNB wanted to offer an alternative to more expensive certification standards, so TQB is an open-source, online rating tool, open to any interested parties. Tools and methods for increasing building sustainability are provided free of charge. ÖGNB also supports the Austrian building and real-estate industry by organising events and conventions for the exchange of knowledge. ÖGNB cooperates with the EU's Green Building Program, and klima:aktiv, the building rating system of the Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management.

In 2009, ÖGNB had eighteen members, including architecture firms, building contractors, construction material production companies, and planning offices. Today that number has risen to 41.[52]

The first ÖGNB certified projects used TQB version 2002, but the standards were updated in 2010. As of March 2014, ninety-nine buildings have been certified, including residential, office, and educational buildings. All the certified projects are in Austria. In addition to the ninety-nine certified projects, there are seventy projects in the process of registration, and 125 registered projects.

| Utilisation | New build | Existing / renovation | Total |
|---|---|---|---|
| **Residential buildings** | 61 | 5 | 66 |
| **Office buildings** | 16 | 4 | 20 |
| **Shops** | 2 | 0 | 2 |
| **Hotels** | 2 | 1 | 3 |
| **Industry** | 1 | 0 | 1 |
| **Education buildings** | 3 | 4 | 7 |
| **Total** | **85** | **14** | **99** |

**Table 4.11. Recently ÖGNB-assessed and -certified projects (March 2014)[53]**

[52] ÖGNB, "Mitglieder der ÖGNB," accessed 22 August 2015, http://www.oegnb.net/mitglieder.htm

[53] ÖGNB, "ÖGNB Projektdokumentation,", access 22 August 2015, http://www.oegnb.net/de/zertifizierte_projekte.htm

TQB documents a building's quality in phases, from planning to construction and finally usage. It has two different rating tools, one for residential buildings and another for commercial buildings. Each of these is divided into five core areas: location and facilities, economic and technical quality, energy and supply, health and comfort, and resource efficiency.

A building can earn 200 quality points in each category, for a maximum score of 1,000. ÖGNB argues that this linear rating tool is more transparent and comprehensive than other rating systems.

| Core Categories for Residential Buildings | Core Categories for Commercial Building |
|---|---|
| **Location and facilities** | |
| Infrastructure | Infrastructure |
| Location safety and building land quality | Location safety and building land quality |
| Facilities quality | Facilities quality |
| Accessibility | Accessibility |
| **Economic and technical quality** | |
| Profitability within the life cycle | Profitability within the life cycle |
| Construction site management | Construction site management |
| Flexibility and durability | Technical property quality |
| Fire protection | |
| **Economic and technical quality** | |
| Energy demand | Energy demand |
| Energy generation | Energy generation |
| Water demand and water quality | Water demand |
| **Health and comfort** | |
| Thermal comfort | Thermal comfort |
| Indoor air quality | Indoor air quality |
| Sound insulation | Sound insulation |
| Daylight and sunlight | Exposure; lighting; sun protection; glare protection |
| **Resource efficiency** | |
| Avoidance of critical material | Avoidance of critical material |
| Regionality, recycling share, certified products | Regionality, recycling share, certified products |
| Eco-efficiency of entire building | Eco-efficiency of entire building |
| Disposal | Disposal |

**Table 4.12. ÖGNB Core Categories**

### Certification process

The general process for building certification from ÖGNB is shown in Figure 4.13. 'General procedure of project certification by ÖGNB'.

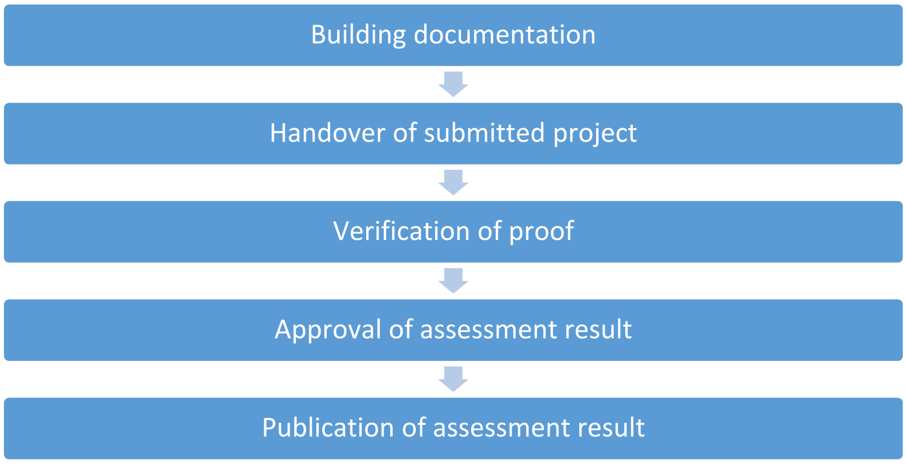



**Figure 4.13. General procedure of project certification by ÖGNB[54]**

ÖGNB offers a free online tool where all the relevant information about a project can be entered, and additional information can be uploaded. This documentation process is supported by a registered ÖGNB consultant, who submits the completed documentation to ÖGNB. This is the client's official application for certification. A nominal fee must be paid after submission of the documentation.

The next step is verification and approval. ÖGNB auditors investigate the documentation. If the auditor approves the documentation, ÖGNB holds a final discussion with all the people involved, including the auditor. The project is then published on its website with its total rating and its ratings in each of the five core categories.

[54] ÖGNB, General procedure of a ÖGNB assessment using TQB, access 01.September 2015 https://www.oegnb.net/en/ablauf.htm

**Certification fee**

The certification fee includes a fee for the ÖGNB consultant, which must be discussed with the consultant themselves, as well as the nominal fee for certifying the building. This also covers the cost of the ÖGNB auditor. For buildings up to 1,000m², the nominal fee is €0.40/m². For buildings between 1,000 and 10,000m², the nominal charge is €400 plus €0.30 for each m² after the first 1,000. For buildings between 10,000 and 25,000m², the fee is €3,100 plus €0.20 for each m² after the first 1,000. For buildings larger than 25,000m², there is a flat fee of €6,100. All fees include VAT.

| Gross floor area (m²) | Planning certification | Construction certification | Total |
|---|---|---|---|
| 150 | 60 | 60 | 120 |
| 500 | 200 | 200 | 400 |
| 1,000 | 400 | 400 | 800 |
| 2,000 | 700 | 700 | 1,400 |
| 3,000 | 1,000 | 1,000 | 2,000 |
| 4,000 | 1,300 | 1,300 | 2,600 |
| 6,000 | 1,900 | 1,900 | 3,800 |
| 8,000 | 2,500 | 2,500 | 5,000 |
| 10,000 | 3,100 | 3,100 | 6,200 |
| 12,500 | 3,600 | 3,600 | 7,200 |
| 15,000 | 4,100 | 4,100 | 8,200 |
| 17,500 | 4,600 | 4,600 | 9,200 |
| 20,000 | 5,100 | 5,100 | 10,200 |
| 22,500 | 5,600 | 5,600 | 11,200 |
| > 25,000 | 6,100 | 6,100 | 12,200 |

**Table 4.13. TQB nominal charges**[55]

[55] ÖGNB, "TQB Nominal Charge," accessed 22 August 2015, http://oegnb.net/en/kosten.htm

## 4.4 GBEL (Three Star) Green Building Evaluation Label

Figure 4.14. GBEL logo.

Recently, China's State Department of Housing and Urban Construction announced the approval of Green Building Rating Standards, number GB/T50378-2014, effective 1 January 2015. The 2006 Green Building Evaluation Standard GB/T50378-2006 was repealed simultaneously. The standard is published by the Ministry of Housing Standard Quota Institute.

The standard aims "to implement the national policy for the technical economy, save the resources, protect the environment [and] specify the assessment of the green buildings and promote the sustainable development." It is "applicable to assessment of green and civil buildings," and considers "the climate, environment, resource, economy, culture, etc. at the place where the buildings are located." Buildings will be assessed according to their "energy, land, water and material saving together with environmental protection within the total service life of the building."[56]

In China, Green building has been recognised as an important objective since the 1990s. Local green building assessment systems were further developed in 2002, spurred by the Olympic Games in Beijing, which prompted development of China's first local green building evaluation and certification system called GOBAS (Green Olympic Building Assessment System), although it was not developed into a national rating tool. In June 2006, the Ministry of Housing and Urban Rural Development (MOHURD) adopted voluntary green building evaluation standards for residential and commercial buildings, and developed technical guidelines and management methods.

In 2013, the State Council Development and Reform Commission created a "green building action plan", which aimed to complete 1 billion $m^2$ of green buildings by the

[56] Ministry of Housing and Urban-Rural Development of the People's Republic of China, "Assessment Standard for Green Building," 15 April 2015.

end of 2015. It suggested that 20% of new buildings should reach the green building standard's required target. Implementation of new "green building rating standards" was to promote the development of green building.

The number of GBEL-certified projects has increased significantly since 2008, when the GBEL certified ten projects: four one-star, two two-star, and four three-star projects.

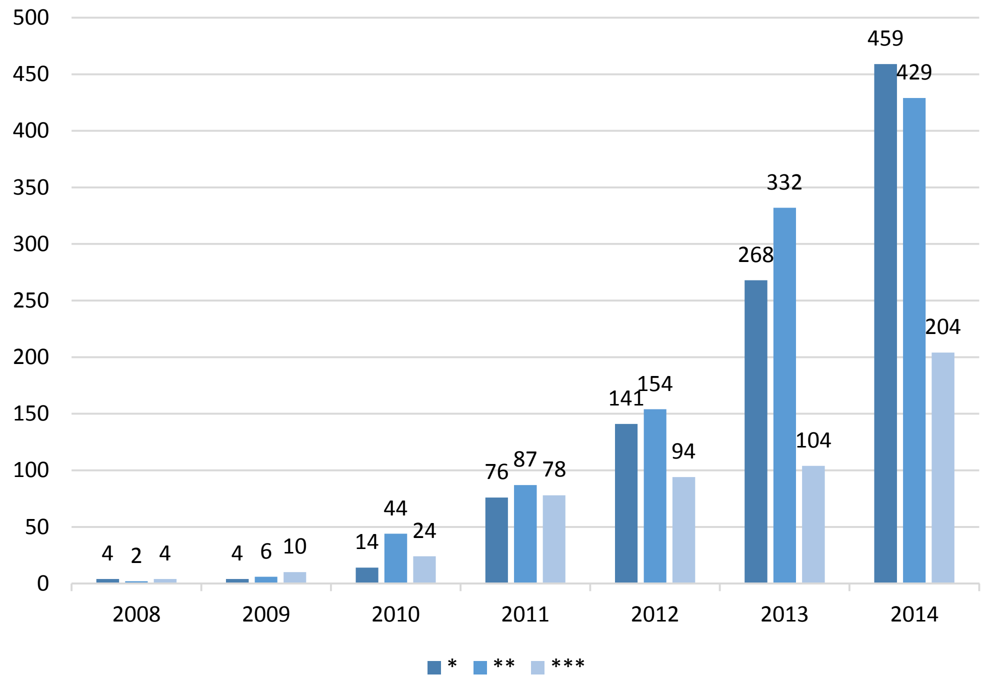



**Figure 4.15. China's green building development**[57]

The 2015 version of GBEL has the strictest requirements of any Chinese regulations so far. It draws on recent practical experience and important research in the field of green architecture. There are six indicators, and buildings can be rated as one, two, or three stars, with three stars being the highest ranking. It covers residential and public buildings, under either the Green Buildings Design Label (GBDL—valid for only two years) or the Operational Green Building Label (GBL).

[57] China Academy of Building Research, access 01.September 2015 http://www.cabr.com.cn/

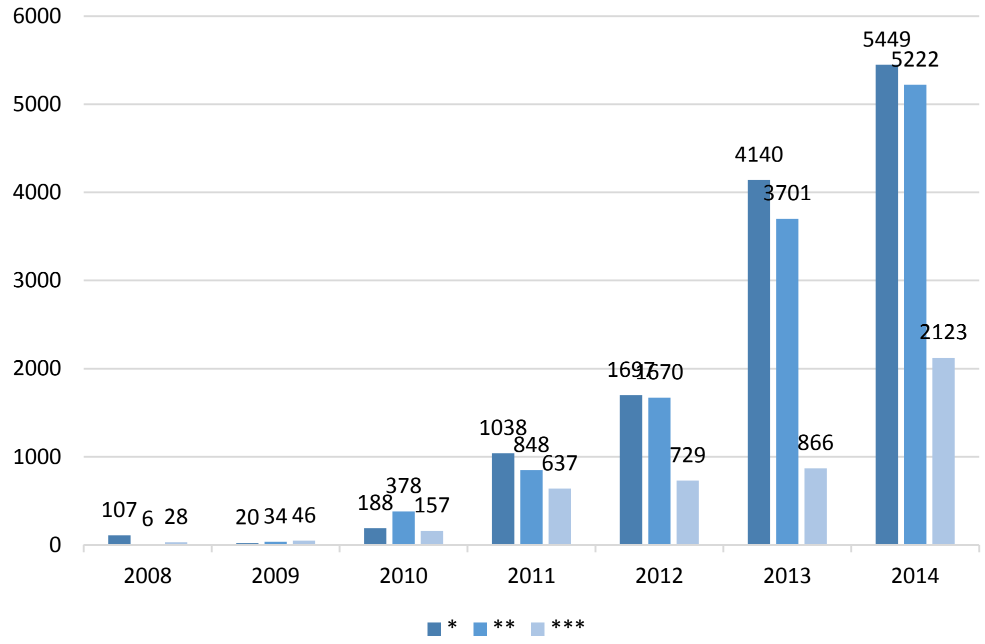



**Figure 4.16. Total gross floor space of certified GBEL projects in China (millions of m$^2$)[58]**

GBEL rates buildings according to mandatory elements, general elements, and preferred elements. Its assessment index includes seven categories: land saving and outdoor environment, energy saving and energy utilisation, water saving and water resource utilisation, material saving and material resource utilisation, indoor environment quality, construction management, and operation management. For each category, there are prerequisites and scoring elements. There are also bonus elements available.

[58] China Academy of Building Research, accessed 22 August 2015, http://www.cabr.com.cn

## GBEL Core Catalogue for residential and public projects[59]

### Land Saving and Outdoor Environment

- Prerequisite Items*
- Scoring Items
- Land Utilisation
- Outdoor Environment
- Traffic Facilities and Public Services
- Field Design and Ecological Environment

### Energy Saving and Energy Utilisation

- Prerequisite Items*
- Scoring Items
- Buildings and Enclosing Structure
- Heating, Ventilation and Air Conditioning
- Lighting and Electricity
- Comprehensive Utilisation of Energy

### Water Saving and Water Resource Utilisation

- Prerequisite Items*
- Scoring Items
- Water Saving System
- Water Saving Instrument and Equipment
- Utilisation of Non-traditional Water Sources

### Material Saving and Material Resource Utilisation

- Prerequisite Items*
- Scoring Items
- Material Saving Design
- Material Adoption

### Indoor Environmental Quality

- Prerequisite Items*
- Scoring Items
- Indoor Acoustic Environment

[59] Assessment Standard for Green Building, issued on 15 April 2014. Implemented on 1 January 2015. Joint Issued by the Ministry of Housing and Urban-Rural Development and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China. Translated by: China Construction Standardization Committee.

- Indoor Lighting and Visual Field
- Indoor Thermal and Humid Environment
- Indoor Air Quality

**Construction Management**

- Prerequisite Items*
- Scoring Items
- Environmental Protection
- Resources Saving
- Process Management

**Operation Management**

- Prerequisite items
- Scoring items
- Management system
- Technical management

There is a maximum score of 100 points for each category; less than forty results in a failing grade. For total scores of over fifty, sixty, or eighty points, buildings are awarded one, two, or three stars respectively. The categories are differently weighted for different building types (residential or public) and different assessment types (design or operation).

| | Design assessment | | Operation assessment | |
|---|---|---|---|---|
| | Residential | Public | Residential | Public |
| Land saving and outdoor environment | 21% | 16% | 17% | 13% |
| Energy saving and utilisation | 24% | 28% | 19% | 23% |
| Water saving and resource utilisation | 20% | 18% | 16% | 14% |
| Material saving and utilisation | 17% | 19% | 14% | 15% |
| Indoor environment quality | 18% | 19% | 14% | 15% |
| Construction management | NA | NA | 10% | 10% |
| Operation management | NA | NA | 10% | 10% |

**Table 4.14. Weight of assessment indexes for GBEL green buildings**[60]

[60] Ministry of Housing and Urban-Rural Development of the People's Republic of China, "Assessment Standard for Green Building," April 15, 2015.

The Green Building Evaluation Label has been conceived of as a nationwide rating system. However, due to China's size and the differing climates and geographies of its many regions, GBEL allows for regional flexibility.

**Certification process and fees**

The certification process involves several people or agencies. The applicant works with the evaluation agency, then an expert committee, and finally with the building authority itself. For a one- or two-star application, materials must be submitted to the local MOHURD office. For a three-star application, they must be submitted to the national Office of Green Building Label Management. The relevant authority processes the application, then forwards it to appointed experts or qualifying office staff.. Green Building Label Management calls for an expert to review and evaluate the project. The report is then sent to MOHURD. Official certification occurs after a thirty-day public review process. The initial application fee is 1000 yuan ($140) for GBEL, with estimated evaluation fees of 40,000 to 50,000 yuan ($5,700 to $7,100).[61]

[61] Nina, Khanna, John Romankiewicz, Wei Feng and Nan Zhou, "Comparetive Policy Study for Green Buildings in U.S and China" (April 2014),;Ernest Orlando Lawrence Berkeley National Laboratory

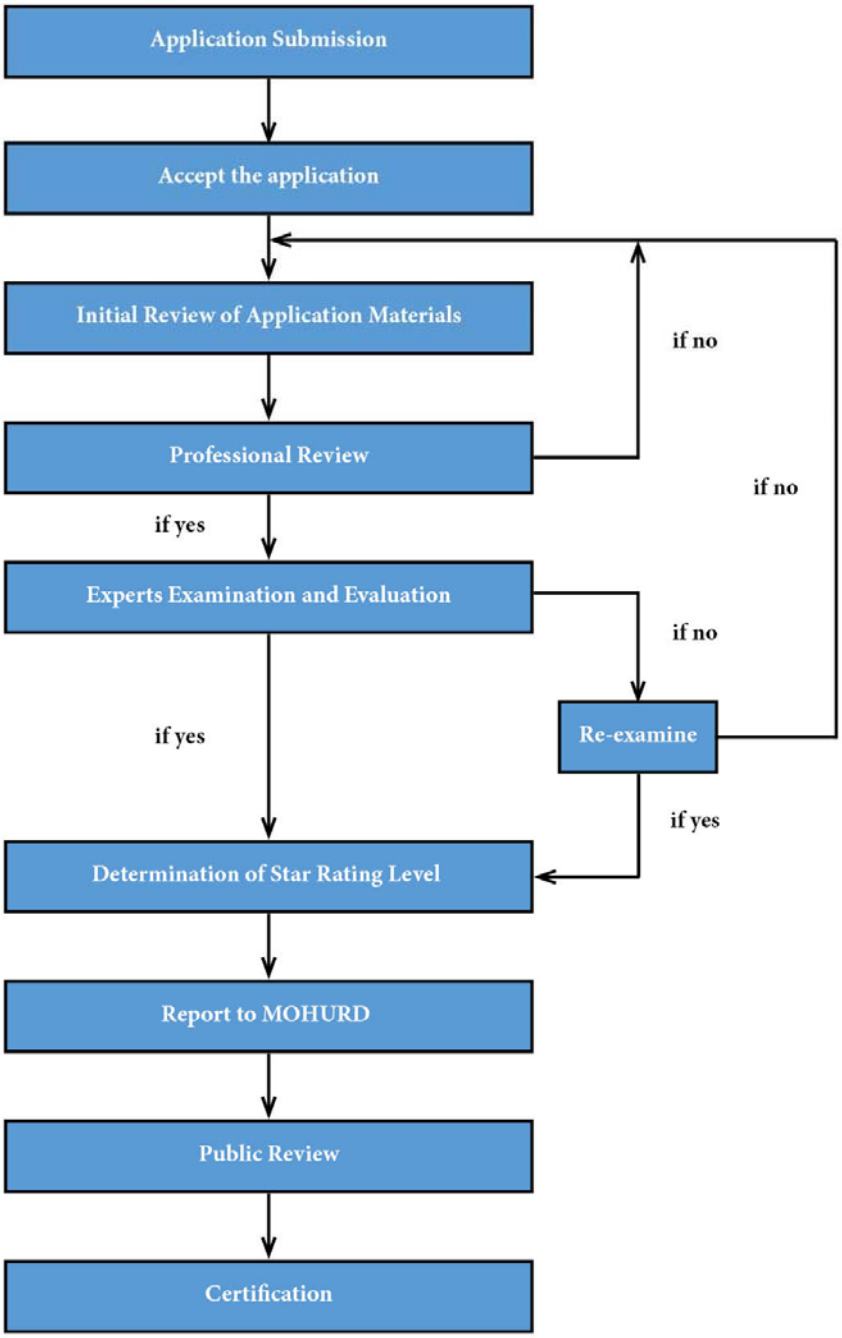



**Figure 4.17. Green Building Evaluation and Label review process[62]**

[62] Li H., Office of Green Building Label Management at Center of Science and Technology of Construction 19 October 2011, MOHURD.

# 5. Key Diversity of the selected green building standards

## 5.1 Introduction

Twenty-five years after the launch of the first green building standard, there are still disagreements, both global and intra-national, about the strategy, development, and execution of such standards. Each certification standard has been developed by an institution or nations in response to unique cultural, political, and environmental concerns. They are not always compatible and there is no obvious way to judge which of them best succeeds in its aims.

The following comparison between four green building standards—LEED, DGNB, ÖGNB, and GBEL—shows important differences, though I do not attempt to judge between them. A clearer understanding of these differences may, however, suggest positive changes that could be made to each standard.

The four standards each rate and certify projects and buildings in a different way. They each have different core categories and weight those categories differently. There are also differences due to the kind of certification offered, whether national or international.

I use the latest version of each standard, and all the following figures, numbers, data, and facts refer to the latest version of each standard.

Table 5.1. 'Organisational differences' shows the organisational differences between the four standards, including their processes of certification and their membership. This

is followed by a more in-depth consideration of each standard's core categories, their criteria, and how the standards weight those criteria.

This comparison will help architects, engineers, investors, and estate agents find the most suitable certification standard for their project.

## 5.2 Organisational differences

LEED is the oldest certification standard, having been launched in 1998, and it is currently the largest, though membership numbers for the GBEL are not available.

LEED is a first-generation standard, while DGNB, ÖGNB, and GBEL are second-generation. They take into account social and economic criteria, and emphasise the entirety of a project's life cycle.

All of the standards rate buildings of different types, including schools, hotels, retail buildings, and offices. LEED and DGNB also allow for certification of urban districts and neighbourhood development. They are also the two standards that certify buildings outside of their countries of origin. ÖGNB and GBEL only certify buildings in Austria and China, respectively. LEED offers additionally a certification tool free of charge for 114 countries (see chapter Appendix I 'LEED Earth')

| | LEED v4 | DGNB core 14 | ÖGNB TQB 2014 | GBELGB / T50378 – 2014 |
|---|---|---|---|---|
| Organisation | United States Green Building Council (USGBC) | German Sustainable Building Council (DGNB) | Austrian Sustainable Building Council (ASBC) | Ministry of Housing and Urban-Rural Development (MOHURD) |
| Membership | 20,000 | 1,200 | 41 | Not suitable; government related |
| Generation | First | Second | Second | Second |
| Launch year | 1998 | 2007 | 2009 | 2008 |
| Latest version | 2014 | 2014 | 2010 | 2014 |

| | | | | |
|---|---|---|---|---|
| Update process | As required | As required | As required | As required |
| Ratings available | Certified, silver, gold, bronze | Pre-certified, certified, bronze, silver, gold | Point system, from 0–100 | One, two, or three stars |
| Units of measurement | U.S. Customary System, Metric | Metric | Metric | Metric |
| Number of criteria | 57 | 40 | 56 | 132 |
| International affiliates | LEED Brazil<br>LEED Canada<br>LEED Emirates<br>LEED India<br>LEED Italy<br>LEED Mexico<br>LEED Earth | DGNB International<br>ÖGNI Austria<br>BGBC Bulgaria<br>DGBC China<br>DGNBH Hungary<br>SGNI Swiss<br>GBCD Denmark<br>TCoSC Thailand | N/A | N/A |
| Process planning scheme | Certificate | Pre-certification, Certification | Certification | Certification |
| Certification types | Building design and construction<br>Interior design and construction<br>Building operation and maintenance<br>Neighbourhood development<br>Homes | Existing buildings<br>New buildings<br>Urban districts | Residential building<br>Commercial buildings | Green building design label<br>Green building label |
| Project types | New construction<br>Core and shell<br>Schools<br>Retail<br>Data centres<br>Warehouse<br>Hospitality<br>Healthcare<br>Commercial interiors<br>Retail | Office and admin<br>Retail<br>Industrial<br>Residential<br>Complete renovation<br>Education<br>Healthcare<br>Hotel<br>Laboratory<br>Mixed-use<br>Urban districts<br>Assembly buildings | Residential Building<br>Office building<br>Shops<br>Hotels<br>Industry<br>Education Buildings | All Civil buildings |
| Operation performance | Three months | N/A | N/A | One year |

| | | | | |
|---|---|---|---|---|
| Certified projects | 72,000 | 1,172 | 224 | 2,538 |

**Table 5.1. Organisational differences**

## 5.3 Categorical differences

The categories and criteria for buildings are the most important part of the standards, and the key differences between them can be found here. Each standard has between five and nine categories.

| LEED v4 | DGNB core 14 | ÖGNB TQB 2014 | GBEL GB / T50378 – 2014 |
|---|---|---|---|
| Location and transportation | Environmental quality | Location and facilities | Land saving and outdoor environment |
| Materials and resources | Economical quality | Economic and technical quality | Energy saving and energy utilization |
| Water efficiency | Sociocultural and functional quality | Energy and supply | Water saving and water resource utilization |
| Energy and atmosphere | Technical quality | Health and comfort | Indoor environment quality |
| Sustainable sites | Process quality | Resource efficiency | Construction management |
| Indoor environmental quality | Site quality | | Operation management |
| Innovation | | | Promotion and innovation |
| Regional priority | | | |
| Integrated process | | | |

**Table 5.3. Categories**

Furthermore, each standard gives greater weight to different categories. Considering which standards weight which categories can help builders and designers choose the most suitable standard for their work.

LEED focuses on energy and atmosphere, which accounts for 36.3% of the total available points (33/110). Location and indoor environmental performance each account for 17.6%, and the six remaining categories share the final 28.5%, as is shown in Figure 5.1. ‘LEED v4 category weighting’.

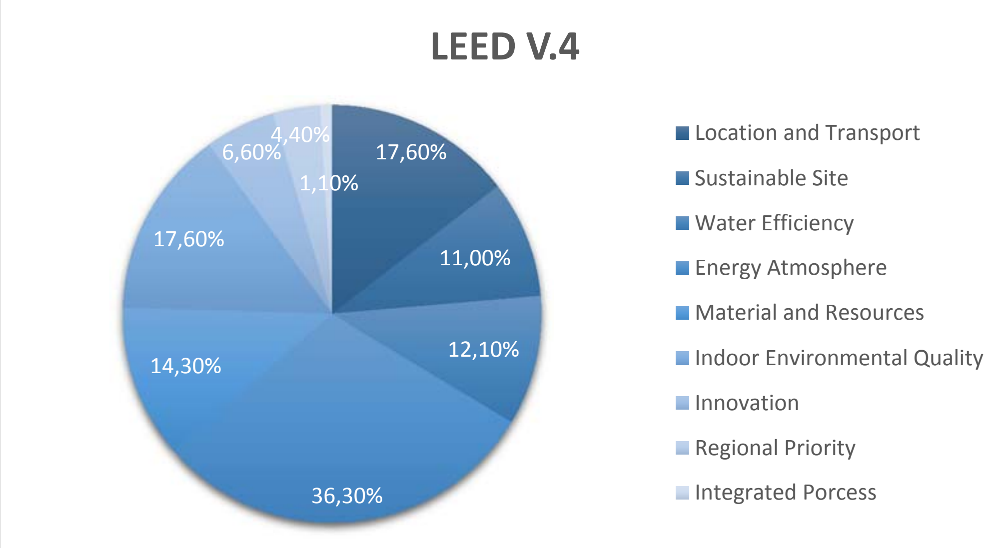



**Figure 5.1. LEED v4 category weighting**

DGNB weights its categories more equally. Other than process quality, DGNB rates all of its categories equally, are almost equal, it varies plus/minus 0.10% of 22.5%. Process quality accounts for 10% of the total available points, as shown in Figure 5.2. ‘DGNB category weighting’.

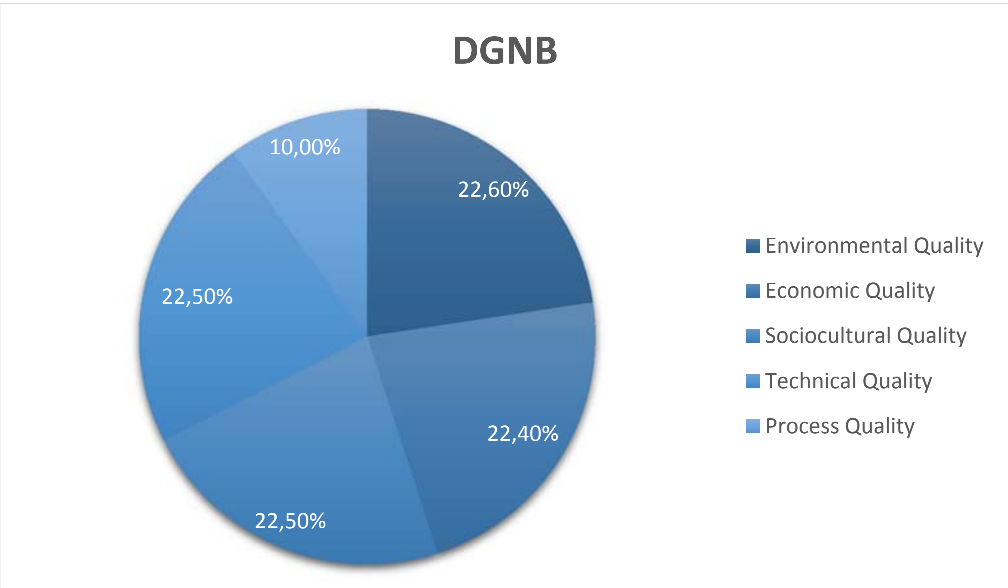



**Figure 5.2. DGNB category weighting**

ÖGNB weights its five core categories equally, at 20% each. (See Figure 5.3.'ÖGNB category weighting'

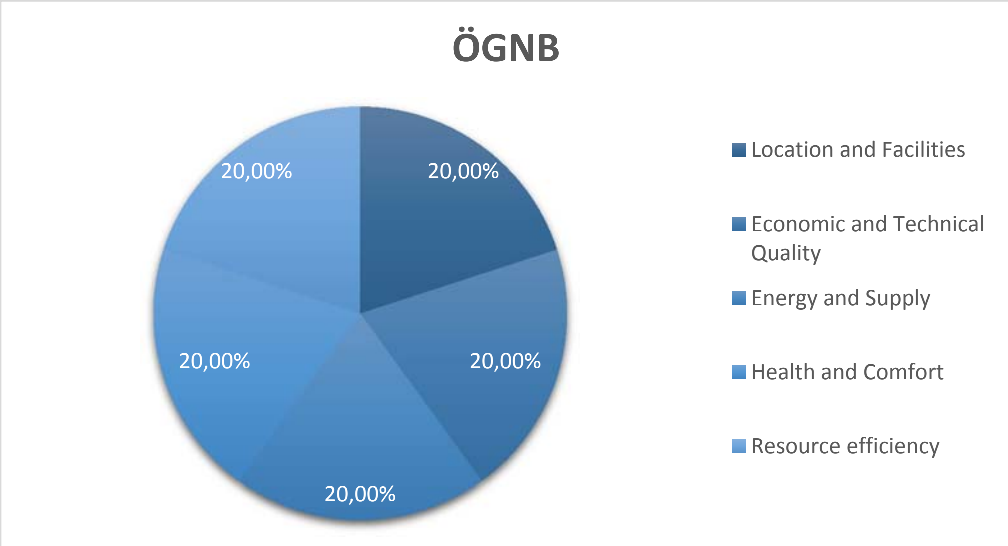



**Figure 5.3. ÖGNB category weighting**

GBEL weights almost all of its categories equally at 14.08% each. The category of innovation, the "extra point[s]" category, is worth just 1.4% of the total (see Figure 5.4 'GBEL category weighting').

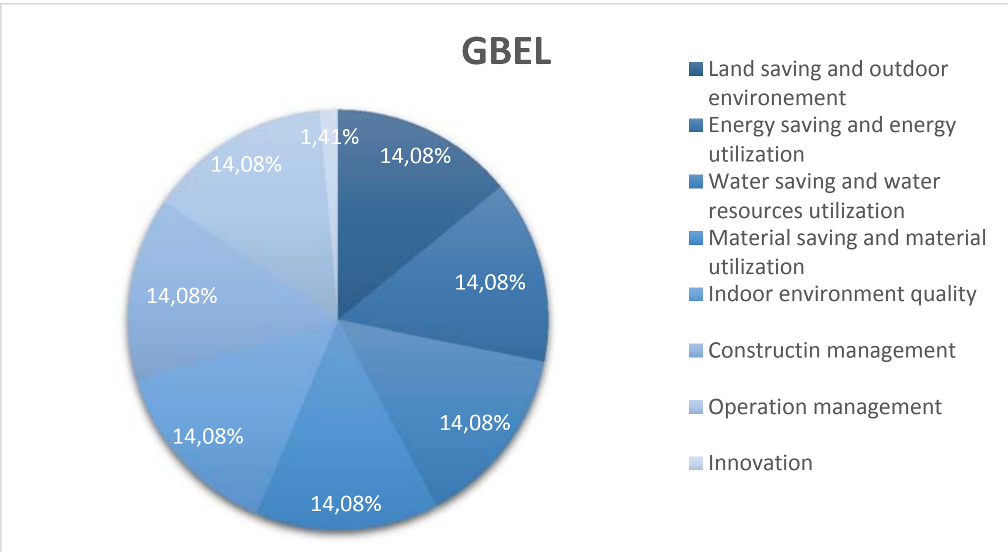



**Figure 5.4. GBEL category weighting**

In short, DGNB, ÖGNB, and GBEL weight their categories in a fairly balanced manner. Only LEED awards very different proportions of points to different categories, which provides a very clear sense of the most important categories within the LEED system.

## 5.4 Criterial differences

It is difficult to compare the four standards' ratings systems, due to the differences between their core categories, their weighting of each category and the different content of the criteria itself. The following table 5.4. 'Comparison with new criteria arrangement' shows one way in which they can be new arrange with the following fourteen new core criteria and create therefore a comparable initial situation.

- **Transportation**
- **Site Quality**
- **Life Cycle**
- **Design & Planning**
- **Light Efficiency**
- **Water Management**
- **Visual Aspects**
- **Air Quality**
- **Acoustic Aspects**
- **Thermal Comfort**
- **Energy Efficiency**
- **Material Efficiency**
- **Technology**
- **Waste Management**

There are, however, differences in how each standard measures these criteria, which the subchapter 5.5 'Differences in weighting of criteria examine.

This table allows us to see what the standards share, but also to see where each standard is missing important criteria. This shows in more detail the priorities of each standard, and thus which standard will best fit a given project, as well as suggesting what criteria the standards might wish to add in their next updates. But it does not describe the technical execution which based on national standards as on political and climate diversity.

| Criteria Categories | LEED V.4 | DGNB Core 14 | ÖGNB TQB 2014 | GBEL GB / T50378 - 2014 |
|---|---|---|---|---|
| | | | **Transportation** | |
| **Public Transport** | Access to Quality Transit | Transport Access | Connection to public transport | Public transport access |
| **Bicycle** | Bicycle Facilities | Cyclist Facilities | Interior development | Parkin area plan |
| **Car Parking** | Reduce Parking Footprint | Commercial Viability | Interior development | Parkin area plan |
| **Green Vehicles** | Green Vehicles | Commercial Viability | | |
| **Accessibility** | | Design for all | Accessibility | Accessible design |
| **Public Access** | | Public Access | | |
| | | | **Site Quality Surroundings** | |
| **Quality of Surrounding** | Surrounding Density and Divers Use | Access to Amenities | Quality of local supply<br>Quality of social infrastructure<br>Proximity to recreation areas and recreational facilities | The site selection accords with local urban plan and meet the construction control requirements of preserved area, historical sites and cultural relics.<br>Site ecology conservation |
| **Land use** | Regional Priority | Land Use | Quality of building land and sealing | Establish construction management system and framework for sustainable building project. Claim responsibility at levels<br>Land use saving |
| **Land Protection** | Sensitive Land Protection | | | Site ecology conservation |

| | | | | |
|---|---|---|---|---|
| **Regional Environment** | Regional Priority | Local Environment | Basic risk of natural hazards | The selected site is free from threat as flood, landslide, and radon-containing soil, and within the safe range of the building site. There is no dangerous sources as hazardous chemicals, flammable explosive hazard and electromagnetic radiation danger.<br>There is no pollution sources exceeding the discharging standard within the site. |
| **Magnetic fields** | | | Alternation magnetic fields in low frequency range | |
| **Heat island** | Heat island reduction | | | Heat island intensity reduction |
| **Environmental Impact** | Construction activity pollution prevention | Environmental impact of Construction | | Develop and implement environment protection plan for the whole construction process by project management department<br>Water saving and consumption plan<br>Construction energy saving plan<br>Dust reduction<br>Noise reduction<br>Design document implementation<br>Ensuring building durability<br>Design change documents control |
| **Art** | | Integrated Public Art | | |
| **Health & Safety management plan** | | | | Make and implement health and safety management plan for constructors by project management department. |

| | | | | |
|---|---|---|---|---|
| | | | | Nuisance less pest control are adopted |
| **Public Image** | | Public Image and Social Conditions | | |
| | | **Life Cycle** | | |
| **Commercial Viability** | | Commercial Viability | | |
| **Life cycle** | Building life cycle impact reduction | Life cycle impact assessment | O13 calculation as leading indicator for eco efficiency of the building | |
| **Life cycle cost** | | Life cycle cost | Profitability analyses LCCA | |
| **Space Flexibility** | | Flexibility and adaptation | Flexibility and durability | Transformable indoor spaces percentage<br>Architectural and structural form regularity |
| **Layout Quality** | | Layout Quality | | |
| **Cleaning and Maintenance** | | Cleaning and Maintenance | | |
| **Facility management** | LEED Accredited Professional<br>Innovation | Documentation for facility management | Basic for building operation | Make and implement management system of energy saving, water saving, material saving and greening<br>Certified Property management agencies<br>Operation procedures and emergency response system<br>Energy saving operation incentive mechanism<br>Green education and publicity mechanism<br>Non-trading water source quality monitoring |

| | | | | Property information management |
|---|---|---|---|---|
| | | **Planning & Design** | | |
| **Comprehensive project brief** | | Comprehensive project brief | | |
| **Integrated planning process** | Fundamental Commissioning and Verification | Integrated design – coordination of all project participants | Integral planning and variation analysis | Integration of civil and decoration construction<br>Integrated civil engineering and decoration work |
| **Competition** | | Design Concept | | Arrange joint conference on key technology of sustainable building design plan before construction |
| **Site assessment** | Site assessment | | | |
| **High Priority Site** | High Priority Site | | | |
| **Sustainability in tender phase** | | Sustainability aspects in tender phase | | Overall plan & orientation |
| **Outdoor space** | Open space | Quality of outdoor space | Quality of open space | Greening rate and accessibility<br>Reasonable greening<br>Trees survival rate |
| **Construction Quality Assurance** | | Construction Quality Assurance | | |
| **Design Planning** | | Design and Urban Quality | Integral Planning and variation analysis | |

| | | | | |
|---|---|---|---|---|
| **Daylight level of surroundings** | | | | The architectural layout of the site meets the daylight standard and does not decrease the daylight level of the surroundings. |
| **Facilities of building object** | | | Facilities of building object | |
| **Safety and Secure** | | Safety and Security | | |
| **Underground space** | | | | Underground space development |
| | | **Light** | | |
| **Daylight** | Daylight | Visual comfort<br>User control | Daylight factor<br>Sun and glare protection | Daylight factor<br>Indoor daylight improvement<br>Adjustable sunshades |
| **Interior Light** | Interior Light | User control | Quality of artificial light<br>Energy efficient lighting | Illuminating system energy-saving control<br>Illumination power density<br>The lighting power density for each room or spaces does not exceed the specified values in existing national standard |
| **Light pollution** | Light pollution reduction | | | Light pollution prevention |
| | | **Water** | | |

| | | | | |
|---|---|---|---|---|
| **Indoor water** | Indoor water use reduction | Drinking water demand and waste water volume | Water saving sanitary facilities | Use water-saving appliances<br>High water use efficiency sanitary device<br>Public water saving measures<br>Water saving cooling technology for Air conditioning |
| **Rainwater** | Rainwater management | Drinking water demand and waste water volume | Rain water use | Landscape watering system<br>Green rainwater facilities<br>Runoff control |
| **Outdoor water** | Outdoor water use reduction | | | Design water supply and drainage system reasonably, optimally and safely<br>Water saving irrigation system<br>Runoff control |
| **User control** | Building level water metering<br>Water Metering | User control | | Make utilization plan for water resource. Utilize and plan all water resources as a whole.<br>Energy-saving facilities and water-saving facilities meet design requirements and work properly.<br>Water metering<br>Other water saving technologies<br>Water consumption limits |
| **Non-traditional water source use** | | | | Non-traditional water source use |

| | | | | |
|---|---|---|---|---|
| **Landscape watering** | | | | Landscape watering system |
| **Individual water billing** | | | Individual water consumption based billing | |
| **Cooling tower water use** | Cooling tower water use | | | |
| **Overall discharge free** | | | | Overall pressure discharge free |
| | | **Visual** | | |
| **View** | Quality View | | | Vision |
| | | **Air** | | |
| **Indoor air quality** | Minimum indoor air quality perform<br>Enhance indoor air quality strategies | Indoor air quality | Ventilation | Natural ventilation optimization<br>Reasonable Air distribution<br>Openable area of façade<br>Site wind environment |
| **Low emission material** | Low-emitting materials | | Low emission and low pollutant construction material in interior fittings | The concentration of indoor air pollutants such as ammonia, formaldehyde, benzene, and TVOC accords with values in the existing national standard |
| **Indoor air quality control** | Indoor air quality assessment | User control | Building Automation and comfort | Intelligent system effectiveness<br>Indoor air quality monitoring |

| | | | | |
|---|---|---|---|---|
| | | | | Underground garages exhausted air monitoring |
| **Smoking** | Environmental Tabaco smoke control | | | |
| **Construction indoor air quality** | Construction indoor air quality management plan | Indoor air quality | Mould and moisture prevention | |
| **Air tightness** | | | Air tightness of the building | |
| | | **Acoustic** | | |
| **Acoustic performance** | Acoustic performance | Acoustic comfort | Room acoustic<br>Noise protection of partition component between building units<br>Impact sound protection of partition ceiling between buildings units<br>Continues noise level / facility noise level | The sound insulation performance of exterior wall, partition, floor, door and window of regularly occupied rooms reaches the lower limits in the existing national standard<br>The indoor noise level of regularly occupied rooms reaches the lower limits in the existing national standard<br>Site Noise<br>Interior noise level (Voluntary)<br>Noise interference reduction<br>Special acoustic design |
| **Sound insulation** | Acoustic performance | Sound insulation | Ambient noise simulation | Sounds insulation performance (Voluntary) |
| | | **Thermal Comfort** | | |

| | | | | |
|---|---|---|---|---|
| **Thermal comfort** | Thermal comfort | Thermal comfort | Thermal comfort in winter<br>Thermal comfort in summer | Thermal insulation performance of roofs, east and west exterior walls meets the requirements<br>For buildings with central heating and air-conditioning systems, design parameters as room temperature, humidity, and fresh air volume accord with the existing national standard<br>Thermal performance optimization of building envelope |
| **Thermal control** | Thermal Comfort | User Control | Building Automation and comfort | Heating and air conditioning adjustable terminals |
| **Thermal bridges** | | Thermal comfort<br>Building Envelop Quality | Thermal bridges of the building | No condensation exists at the inner surface of building envelope with indoor design temperature and humidity. |
| | | **Energy** | | |
| **Minimum Energy** | Minimum Energy Performance<br>Optimize Energy Performance | Life cycle impact assessment | Primary energy demand<br>Heat consumption HWB<br>Colling consumption | Building design complies with the mandatory provisions in the existing national standards for building energy saving.<br>Electricity consumption reduction on circulation pump<br>Chill heat source units energy efficiency optimization<br>HVAC efficiency<br>Elevator energy saving<br>Energy saving electrical equipment<br>Air exhaust energy recovery system<br>Cold and heat storage system |

| | | | | |
|---|---|---|---|---|
| | | | | The electric heating installations is not used directly as the heat source of air conditioning or heat source of air humidification system |
| **Energy user control** | Building Level Energy Metering<br><br>Advanced Energy Metering | User control | Building Automation and comfort | Energy-saving facilities and water-saving facilities meet design requirements and work properly.<br><br>Monitoring system of heating, ventilation, air conditioning and lighting etc. works properly and the operation condition is completely recorded<br><br>Transition season measure<br><br>Partial load reduction measures<br><br>Measure energy consumption of chill-heat source, distribution system and lighting system independently. |
| **Demand Response** | Demand Response | | | |
| **Renewable Energy** | Renewable Energy Production<br><br>Green power and carbon offset | Life Cycle Impact Assessment | Energy from photovoltaic | Renewable energy utilization |
| **Material** | | | | |

5. Key Diversity of the selected green building standards

| | | | | |
|---|---|---|---|---|
| **Local Materials** | Low Emitting Materials | Local Environment Impact | Avoidance of CFC<br>Avoidance of PVC | |
| **Environmental certificates** | Building Product Disclosure and Optimization – Environmental Products<br>Building Products Disclosure and Optimization – Sourcing and Raw Materials | Responsible Procurement protect forest, exclude child labour | Use of production with environmental certificates | Construction materials and products prohibited and restricted by local and national government must not be used. |
| **Material recycling** | Building life cycle impact reduction<br>Storage and collection of recyclables | Deconstruction and Disassembly | Use of recycling material | Reusable and recyclable material<br>Waste material utilization<br>Durable decoration materials |
| **Refrigerant** | Enhanced refrigerant management<br>Fundamental Refrigerant Material | | | |
| | | | | The outline of the building is concise with no excessive decorating member. |

| | | | | |
|---|---|---|---|---|
| **Electrostatic floor** | | | Electrostatic floor covering charge | |
| **Steel bar** | | | | Use hot rolled ribbed steel bar no less than 400 Mpa as bearing force reinforcement bars for beams and columns of concrete structure |
| **Regional products** | | | Use of regional products | Adoption of local produced building material |
| **Environment impact of construction** | Constructing activity pollution prevention | Environment impact of Construction<br>Construction Quality Assurance | | Prefabricated elements use percentage<br>Ready mixed concrete<br>Adoption of mixed mortar<br>High strength structure material<br>Optimized structure design<br>High-durability material<br>Integrated kitchen and toilet design<br>Locally produced material<br>Reducing the loos of steel bars<br>Ready mixed concrete |
| **Technical** | | | | |
| **Service technology** | | Adaptability of technical systems | Approval building service technology | Inspection and optimization of public facilities and equipment<br>Inspection and cleaning of air conditioning and ventilation system |

| | | | | |
|---|---|---|---|---|
| **Burglary protection** | | | Burglary protection and safety | |
| **Fire Safety** | | Fire Safety | Special fire extinguisher systems and fire alarm facilities | |
| **Debugging electrical system** | | Systematic Commissioning | | Debugging and test of mechanical and electrical system |
| | | **Waste** | | |
| **Waste management** | Construction and demolition waste<br>Construction and demolition water management | Deconstruction and disassembly | Waste management | Make waste manage system<br>Categorised garbage collection and processing<br>Garbage collection statin stink free |
| **Waste storage** | Storage and collection | Deconstruction and disassembly | Disposal indicator | Waste reduction |

**Table 5.4. Comparison with new criteria arrangement**

The criteria can be divided according to how many of the four standards include them. These distinctions then allow me to outline the missing criteria of each the standards. Because of focusing on the differences between the standards, I will set aside those criteria that are included in all four categories. There are also a number of criteria that feature only in one of the standards. These idiosyncratic categories are likely the result of local political, cultural, or environmental conditions, although it could provide some new ideas for the other standards what could be also be new implemented in their standards based on their countries specification.

In between are those criteria present in two or three of the standards. I will focus on these groups here, as they are the criteria that are generally applicable, and are so more likely to be included in updated versions of each standard.

| Criteria | Absent in Standard |
|---|---|
| Low emission material | DGNB |
| Life cycle assessment | GBEL |
| Life cycle cost | GBEL |
| Local Material CFC and PVC | GBEL |
| Accessibility | LEED |
| Space Flexibility | LEED |
| Thermal bridges | LEED |
| Service technology | LEED |
| Design Planning | ÖGNB |
| User control water | ÖGNB |
| Environment impact of construction | ÖGNB |

**Table 5.5. Criteria present in three standards**

| Criteria | Absent in Standard |
|---|---|
| Green vehicles | ÖGNB; GBEL |
| Land Protection | DGNB; ÖGNB |
| Heat Island | DGNB; ÖGNB |
| Sustainability in tender phase | LEED, ÖGNB |
| Competition | LEED; GBEL |
| Light pollution | DGNB; ÖGNB |
| Outdoor water | DGNB ÖGNB |
| View | DGNB; ÖGNB |
| Regional products | LEED; DGNB |
| Fire safety | LEED; GBEL |
| Debugging | LEED; ÖGNB |

**Table 5.6. Criteria present in two standards**

| Criteria | Containing standard |
|---|---|
| Art | DGNB |
| Building Envelop Quality | DGNB |
| Cleaning and Maintenance | DGNB |
| Commercial Viability | DGNB |
| Comprehensive project brief | DGNB |
| Construction Quality Assurance | DGNB |
| Layout Quality | DGNB |
| Public Access | DGNB |
| Public Image | DGNB |
| Safety and Secure | DGNB |
| Daylight level of surroundings | GBEL |
| Health & Safety management plan | GBEL |
| Landscape watering system | GBEL |
| No decorating | GBEL |
| Noise reduction | GBEL |

| | |
|---|---|
| Non trading water system | GBEL |
| Overall pressure discharge free | GBEL |
| Pest control | GBEL |
| Reinforcement | GBEL |
| Steel bar | GBEL |
| Steel framework | GBEL |
| Underground garages air monitoring | GBEL |
| Underground space | GBEL |
| Water consumption limits | GBEL |
| Cooling tower water use | LEED |
| Demand Respond | LEED |
| Enhance Refrigerant | LEED |
| High Priority Site | LEED |
| Site assessment | LEED |
| Smoking | LEED |
| Airtightness of the building | ÖGNB |
| Burglary protection | ÖGNB |
| Electrostatic floor | ÖGNB |
| Facilities of building objects | ÖGNB |
| Individual water billing | ÖGNB |
| Magnetic fields | ÖGNB |

**Table 5.7. Criteria present in only one standard**

Table 5.7 Criteria present in only one standards could lead to the acceptance that DGNB and GBEL are the most innovative due to the fact that their standards have more criteria only present in their standards

On the other hand LEED and ÖGNB are using criteria which a more common in all the compared four standards.

## 5.5 Differences in weighting of criteria

Combining these new groups of core criteria with the standards' original weightings makes it easier to see how the standards differ. The exact calculations can be found in appendix I, "New Points Distribution." As the tables there show, the existing weightings of each criteria are still used, but with a new calculation and point's distribution that facilitates comparison of the four standards. The results can be seen in which visualise how the points distribution relates to the new core categories.

In particular, Figure 5.12, 'Weighting Based on new core categories' summarises and shows clearly which criteria are important for which standards and therefore have higher points allocations than others. This figure shows where the focus of each standard is—and which categories they neglect. It is especially striking that DGNB focuses on the life cycle of the building and on the planning and design category. LEED emphasises energy and water use, and air quality. ÖGNB and GBEL distribute weight more evenly, but still ÖGNB highlights energy use and GBEL energy, water, and site quality category

By comparing the point's distribution in the different standards, we might come to the conclusion that GBEL took LEED as a reference and developed it further, since LEED and GBEL have similar points distributions. This is also shown in section 3.1, "Evolution of Green Building Standards."

The DGNB standard developed in a different direction, with more focus on concerns typical of second-generation standards, like life cycle and planning design.

ÖGNB is the most balanced standard in the weighting of its criteria, a feature that comes from its different history and evolution.

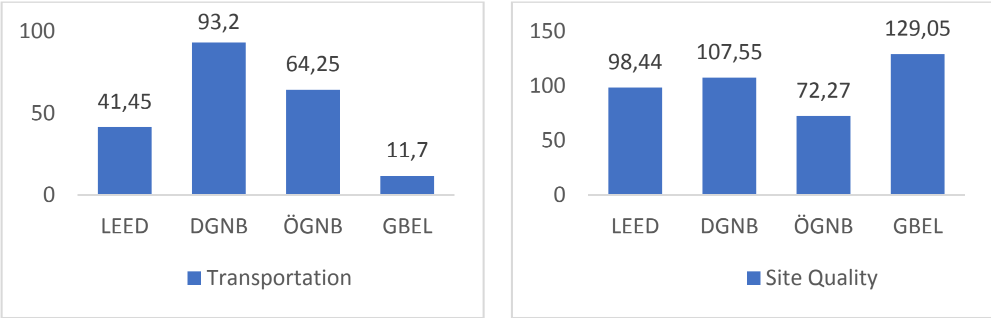



**Figure 5.5 Weighting of transportation (left) and site quality (right)**

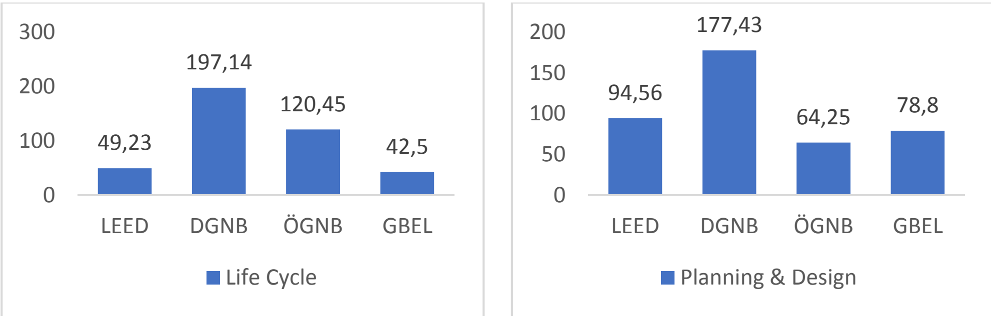



**Figure 5.6. Weighting of life cycle (left) and planning & design (right)**

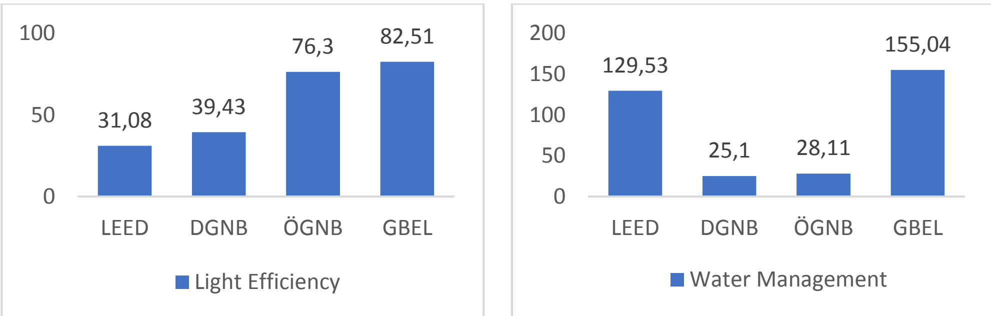



**Figure 5.7. Weighting of light efficiency (left) and water management (right)**

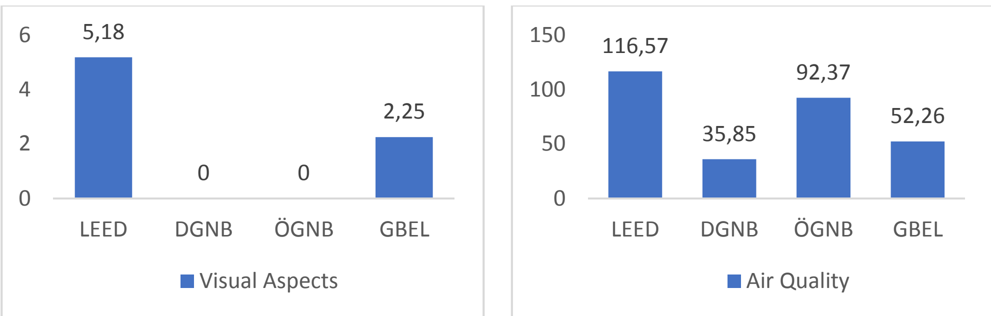
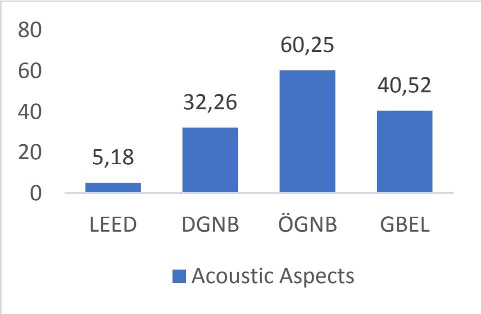



**Figure 5.8. Weighting of visual aspects (left) and air quality (right)**



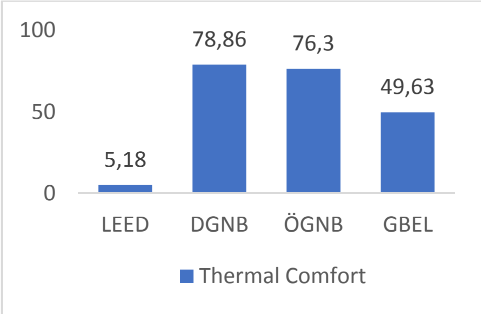
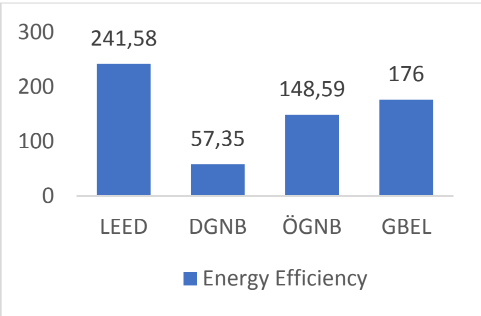




**Figure 5.9 Weighting of acoustic aspects (left) and thermal comfort (right)**



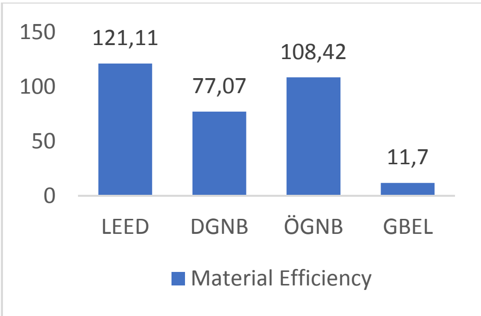
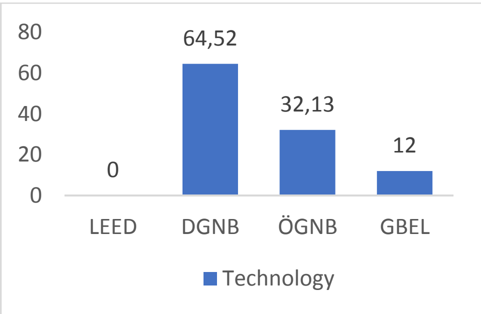




**Figure 5.10 Weighting of energy efficiency (left) and material efficiency (right)**



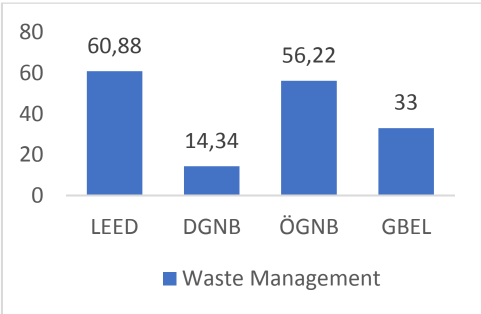




**Figure 5.11. Weighting of technology (left) and waste management (right)**

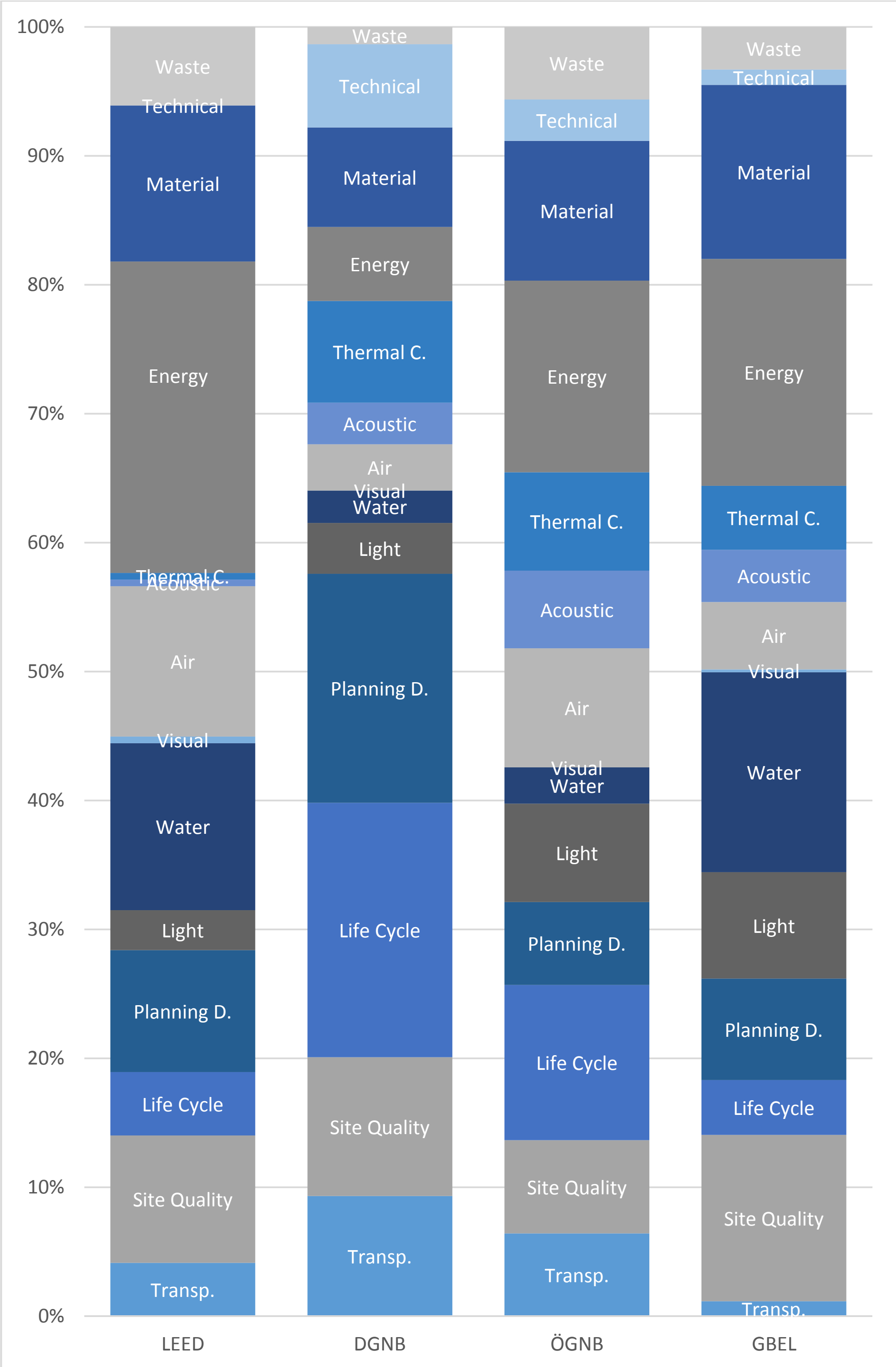



**Figure 5.12. Weighting based on new core categories**

Based on our new arrangement of the criteria, and our new point system, we can compare the total performance indexes of the four standards and draw further conclusions. Each green building standard has different levels that can be achieved within it, except for ÖGNB, which is a linear rating tool without levels. Figure 5.13 'Total performance index based on the new and equal point system' shows, for instance, that achieving the highest level in GBEL is more difficult than achieving the highest level of LEED certification. Furthermore, we can see that the rating systems have a different minimum standard, with the Bronze level of DGNB being the easiest to achieve among those standards offering graded certifications.

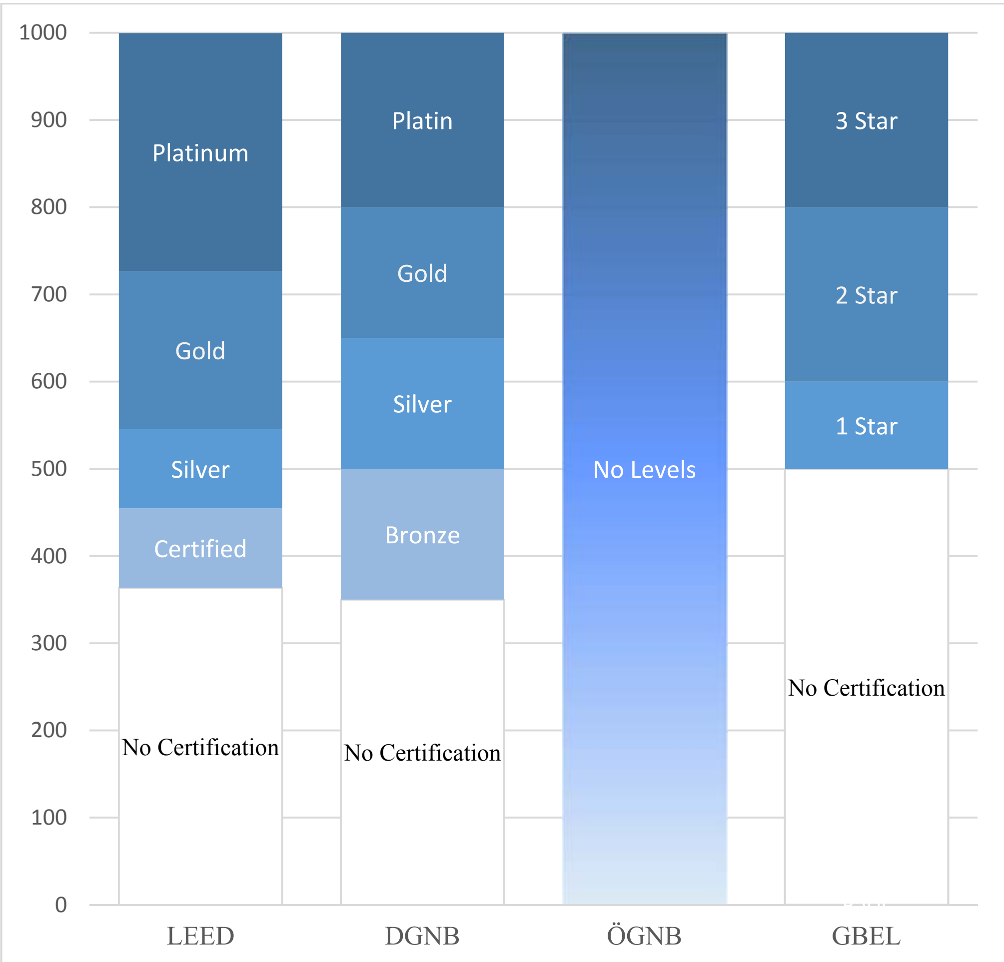



**Figure 5.13. Total performance index based on the new and equal point system.**

# 6. Discussion

There are many ways to arrange and categorise green building standard criteria. My arrangement was determined by a desire to keep the criteria comprehensive and clear; to create as many criteria as needed to provide detailed information; and to use the existing criteria from LEED, DGNB, ÖGNB, and GBEL wherever possible.

Some of the existing criteria are very clear, but many of them are poorly defined, and could correspond to many criteria in other standards. Because of this lack of clarity in the original criteria, I sometimes needed to use criteria several times to attain an accurate comparison.

To produce an accurate weighting of the criteria (Figure 5.12. Weighting based on new core criteria), I had to create a new way to calculate the weighting, taking into consideration the standards' own existing methods. I used a point system with a total possible score of 1000. I then divided the 1000 points according to each standards' own weighting, including the mandatory criteria. Finally, I assigned this ratio to the existing criteria to get four commensurate weightings. The complete point's distribution is shown at chapter Appendix I 'New point's distribution'.

Furthermore there are different ways how to arrange the criteria and the categories also with a different rating system. My aim was it to make it very clear and comprehensive for everyone. The aim of this work is to address average people which is necessary to create a change

All statistical data here come from sources related to my own topic. While other sources could provide different statistics (this is very likely when it comes to climate change, demographics, and economic facts) my own sources can be trusted, because I just used the data from the original and official documents or websites which are academically approved institutes.

I was not able to take into account all existing green building standards. There are far more standards than the four that I have chosen to examine, and the differences between those others is a topic for future research.

LEED, DGNB, ÖGNB, and GBEL all have a very strict privacy policy. I had originally planned to compare case studies of buildings that the standards had certified, but that proved to be impossible despite several reason like privacy policy, building documentation, and location. However, that the data I was able to use are sufficient to show the differences between the standards. The key differences can be understood, and communicated to architects, engineers, and investors, without investigating individual buildings. Comparing individual buildings would, however, be an interesting and valuable avenue for further research which would be just possible by following the whole process from the beginning of the planning phase.

# 7. Conclusion & directions for future research

At the outset of this research, there was no clear, existing notion of the differences between green building standards. Also, though each standard is clearly defined and divided into internal criteria, there was no way of rigorously and quantifiably comparing the standards against each other—a task made difficult by the presence of different criteria, categories, and weightings across the standards under consideration. This gap has now been filled.

The work was split in into five successive steps, beginning from the thesis's key aim of finding the crucial differences between the standards. In the first and second parts, we established the research question and gave a general overview of the history and development of green building systems. The third part specifically investigated green standards under comparison to gather information for the fourth part, in which the standards were compared on an equal footing by defining new categories into which the criteria could be assigned for evaluation. It was also possible, through the development of a new point system, to create a new rating system against which the four standards could be objectively evaluated. This highlighted the differences in how the standards categorised and weighted their criteria.

This thesis took three major approaches in its evaluation of the standards, to:

1. identify which criteria each standard placed in each category, and which criteria or categories were lacking from particular standards
2. examine how each standard weights its categories and criteria, to identify its focus
3. visualise the difficulty of achieving certification levels in the standards that are so divided, to identify which of the standards are the most and least stringent

A cynic could see the research outcomes as a manual for how to achieve a green building certification with the least effort. Yet, it still represents far better and more sustainable practice to achieve the lowest possible certification level (Bronze in DGNB), or the lowest top-level certification (Platinum in LEED), than to not attempt certification at all. Every step in this direction should be encouraged that we may don't have to read such news again as published few days ago.

On 26 August 2015, NASA Earth Science Division director Michael Freilich said that "sea-level rise is one of the most visible signatures of our changing climate, and rising seas have profound impacts on our nation, our economy and all of humanity." He presented a new digital visualisation of sea-level change. Within the next 100 to 200 years, we can expect sea levels to rise one to two metres. Under such conditions, islands and megacities like Tokyo or Singapore will drown. A one-metre rise in sea level would affect more than 150 million people, most of them in Asia.[63]

A report in the August 2015 issue of the journal *Nature Climate Change*, based on the research of the Stockholm Environment Institute, covered the Kyoto protocol and related trade in climate certificates. Russia and Ukraine earn millions of dollars by selling their certificates. Russian and Ukrainian businesses are run inefficiently in order to obtain more certificates in the following year, which they can sell to other European countries. Given such poor behaviour in the face of such dire predictions, the future could look dark. But it is not too late for us to change it.

Over the quarter of a century since the launch of BREEAM in 1990, green building certification standards have become ever more sophisticated. They encompass more and more effective categories and criteria. They encourage ever greater efficiency in the use of both energy and resources, creating more sustainable buildings.

But we should also consider what further steps we can take to make buildings even greener. How can we provide even more momentum for improvements in building standards? How can we raise awareness of existing standards, while also encouraging

[63] NASA, "Climate Change Impact: NASA's 21st Century Predictions," accessed 30 August 2015, http://www.space.com/22965-climate-change-impact-nasa-s-21st-century-predictions-video.html.

newer, more effective systems—and awareness, too, of the need to protect the environment? We talk about second-generation building standards—but what will the third and fourth generations look like? Will it be like science fiction?

Each certification standard should evaluate inclusion of those criteria from other standards that it is missing, and take the whole life cycle of a building into account, not just its construction. Considering users' behaviour is also very important. Should there be more and more equipment to prescribe how the user should behave, or should the third-generation standards be more enabling for users? To become more relevant to our daily lives, next-generation building standards would do well to facilitate users' needs, rather than forcing them to act in particular ways.

Iceland consumed more electricity per capita than anywhere else in the world in 2014, at 51,142 kWh per capita in 2014. Lichtenstein consumed 36,448 kWh per capita; Norway, 23,486 kWh per capita.

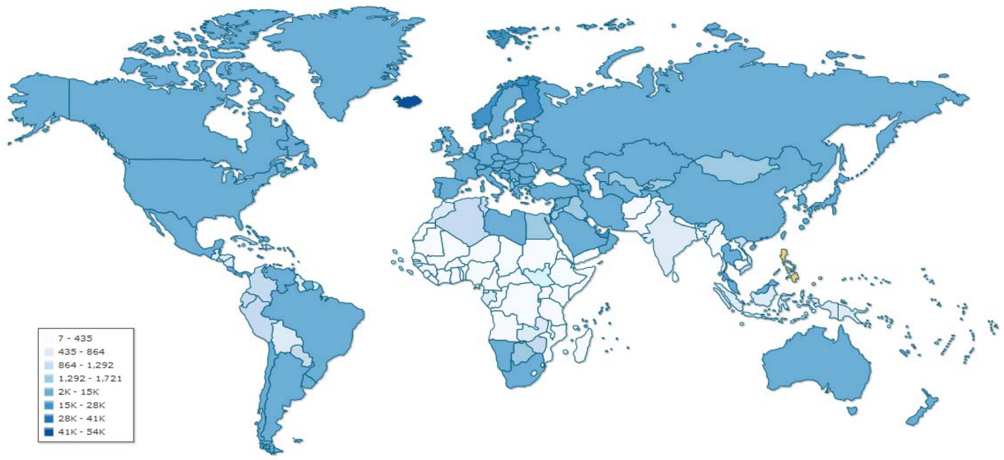



**Figure 7.1. Electricity consumption per capita**[64]

How can we reduce individual energy consumption across the globe? Perhaps the fourth generation of green building standards could include something like energy rationing. We could use new mobile technologies to measure our personal energy consumption. If everyone knew how much energy they used, they would surely be

[64] "Electricity consumption per capita", indexmundi.com/map/?v=81000 (accessed 28 August, 2015).

more conscious of their impact on the environment. Individuals who limited their consumption could be rewarded—through incentive schemes similar to credit-card and airline reward programs. This would nudge us all towards more conscientious energy conservation, the use of more efficient computers, home appliances, and air conditioning—which would in turn encourage industries to continue development of energy-efficient products.

Buildings, of course, need a lot of energy, but if we could make building efficiency matter to a building's users, as well as its designers and builders, green building standards could become even more helpful. If users demand more efficient buildings, builders will be more willing to experiment, for instance, with increased use of local materials.

Such a program could be expanded to almost all aspects of our lives: our homes, our transportation, and our workplaces. It could even encourage a greater sense of community: helping your neighbour with her bags, so she doesn't have to use a car, would benefit you both.

The idea is similar to the movie *In Time*, written and directed by Andrew Niccol. In this dystopian, science-fiction thriller film, people stop aging at twenty-five, and everyone has a clock on their arm that counts down how long they have to live. In my version, however, the user would get a benefit from the measurement of energy usage, rather than a punishment.


**Figure 7.2. *In Time* (film), Twentieth Century Fox**[65]

[65] Image from *In Time*, accessed 28 August 2015, cdn.collider.com/wp-content/uploads/in-time-movie-image-forearm-01.jpg.

As the many different green building standards are updated over time, they are becoming more and more similar. In the coming decades they might become more or less homogenous in their aims and criteria. But the differences between LEED, DGNB, ÖGNB, and GBEL are more important than their similarities. I have shown that these standards differ significantly in their memberships and in the ways they certify and register projects. They each require different criteria, of which LEED and GBEL share many, as do DGNB and ÖGNB. Each standard also weighs its criteria differently. DGNB, ÖGNB, and GBEL are more balanced than LEED, which places a great deal of weight on criteria to do with energy consumption.

If one standard's criteria or weighting is more effective than the others', those criteria or that system of weighting should become standard across the different systems. This is the benefit of having four diverse rating systems at present: they allow for innovation and experimentation.

So, at present, it is less important that designers and builders use a specific green building standard than that they choose one at all. Each step towards sustainability and green building is important.

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# Appendix I

## List of figures

# List of tables

# Acronyms and abbreviations

## Green Building Standards

| | |
|---|---|
| ASBC | Austrian Sustainable Building Council |
| ASHREA | American Society of Heating |
| BERDE | Building for Ecologically Responsive Design Excellence |
| BGBC | Bulgarian Green Building Council |
| BNB | The assessment System for Sustainable Building |
| BREEAM | Building Research Establishment Environmental Assessment Methodology |
| CASBEE | Comprehensive Assessment System for Building Environmental Efficiency |
| CEPHEUS | Cost Efficient Passive House as European Standards |
| DGNB | Deutsche Gesellschaft für Nachhaltiges Bauen (e.V.: German Sustainable Building Council) |
| EDAMA | Energy, Water& Environment productivity |
| Estidama | Building design methodology for construction and operating buildings and communities |
| GBAS | China's Green Building Assessment Method |
| GBCA | Green Building Council Australia |
| GBCI | Green Building Council Indonesia |
| GBC | Green Business Certification |
| GBEL | Green building energy label |
| GBI Malaysia | Green Building Index Malaysia |
| GRIHA | Green Rating for Integrated Habitat Assessment |
| HQE | Haute Qualite Environnemental (e.V.: High Quality Environmental standard) |
| IBO | Austrian Institute for Healthy and Ecological Building |
| IGBC | Indian Green Building Council |

| | |
|---|---|
| JaGBC | Japan GreenBuild Council |
| JSBC | Japan Sustainable Building Consortium |
| KGBC | Korea Green Building Council |
| LEED | Leadership in Energy & Environmental Design |
| MOHURD | Ministry of Housing and Urban Rural Development |
| Nabers | National Australian Built Environment Rating System |
| NAHB | The National Association of Home Building |
| ÖGNB | Österreichische Gesellschaft für Nachhaltiges Bauen |
| ÖGNI | Österreichische Gesellschaft für Nachhaltige Immobilienwirtschaft |
| POE-O | Protect of the Environment Operations |
| SGNI | Swiss Sustainable Building Council |
| TQB | Total Quality Building |
| USGBC | United States Green Building Council |

## General

| | |
|---|---|
| COP | Conference of the parties |
| CRI | Climate Risk Index |
| DOE | US Department of Energy |
| GDP | Gross domestic production |
| GHG | Greenhouse gas |
| IEA | International Energy Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| NASA - GISS | Goddard Institute for Space Studies |
| NASA | National Aeronautics and Space Administration |
| OECD | Organization for Economic Co-operation and Development |

| | |
|---|---|
| OFEE | United States Office of the Federal Environmental Executive |
| UK | United Kingdom |
| UN | United Nations |
| UNCHE | United Nations Conference on the Human Environment |
| UNDESA | United Nations Department of Economic and Social Affairs |
| UNEP | United Nations Environment Program |
| UNEP-SBCI | United Nations Environment Program-Sustainable Buildings and Climate Initiatives |
| PJ | |
| EJ | |
| UNFCCC | The United Nations Framework Convention on Climate Change |

## New Calculation distribution

| | |
|---|---|
| EVP | Existing Evaluation Points |
| MF | Multiplication factor |
| EXP | Existing Points |
| PRI | Points for Requirement Index |
| VAI | Various Assessment Index |
| MX | Multiplication factor |
| NP | New Points |
| RG | Relevance Factor Exiting |

# LEED Earth

## Countries that are eligible for free LEED certification

Afghanistan
Albania
Algeria
Andorra
Angola
Antigua and Barbuda
Armenia
Azerbaijan
Barbados
Belarus
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
Comoros
Cyprus
Dominica
Equatorial
Guinea
Guinea
Guinea Bissau
Guyana

Iceland
Iraq
Jamaica
Kazakhstan
Kiribati
Kyrgyzstan
Laos
Latvia
Lesotho
Liechtenstein
Lithuania
Macedonia
Malawi
Maldives
Mali
Marshall
Islands
Mauritania
Mauritius
Micronesia
Moldova
Monaco
Mongolia
Montenegro
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Nicaragua

Niger
Nigeria
Oman
Palau
Papua New Guinea
Rwanda
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Samoa
San Marino
Sao Tome and Principe
Senegal
Seychelles
Seychelles
Sierra Leone
Slovenia
Solomon
Islands
Solomon Islands
Suriname
Swaziland
Tajikistan
Tanzania
Timor-Leste
Togo
Tonga
Trinidad and Tobago
Tuvalu
Uganda

| | | |
|---|---|---|
| Uzbekistan | Vanuatu | Zimbabwe |

# The Kyoto Protocol

## Annex

**Declaration of the United Nations Conference on the Human Environment**

The United Nations Conference on the Human Environment, having met at Stockholm from 5 to 16 June 1972,having considered the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment,

Proclaims that:

1. Man is both creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evolution of the human race on this planet a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights the right to life itself.

2. The protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments.

3. Man has constantly to sum up experience and go on discovering, inventing, creating and advancing. In our time, man's capability to transform his surroundings, if used wisely, can bring to all peoples the benefits of development and the opportunity to enhance the quality of life. Wrongly or heedlessly applied, the same power can do incalculable harm to human beings and the human environment. We see around us growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross deficiencies, harmful to the physical, mental and social health of man, in the man-made environment, particularly in the living and working environment.

4. In the developing countries most of the environmental problems are caused by under-development. Millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should make efforts to reduce the gap themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development.

5. The natural growth of population continuously presents problems for the preservation of the environment, and adequate policies and measures should be adopted, as appropriate, to face these problems. Of all things in the world, people are the most precious. It is the people that propel social progress, create social wealth, develop science and technology and, through their hard work, continuously transform the human environment. Along with social progress and the advance of production, science and technology, the capability of man to improve the environment increases with each passing day.

6. A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a

better life in an environment more in keeping with human needs and hopes. There are broad vistas for the enhancement of environmental quality and the creation of a good life. What is needed is an enthusiastic but calm state of mind and intense but orderly work. For the purpose of attaining freedom in the world of nature, man must use knowledge to build, in collaboration with nature, a better environment. To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development.

7. To achieve this environmental goal will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level, all sharing equitably in common efforts. Individuals in all walks of life as well as organizations in many fields, by their values and the sum of their actions, will shape the world environment of the future.

Local and national governments will bear the greatest burden for large-scale environmental policy and action within their jurisdictions. International cooperation is also needed in order to raise resources to support the developing countries in carrying out their responsibilities in this field. A growing class of environmental problems, because they are regional or global in extent or because they affect the common international realm, will require extensive cooperation among nations and action by international organizations in the common interest.

The Conference calls upon Governments and peoples to exert common efforts for the preservation and improvement of the human environment, for the benefit of all the people and for their posterity.

Principles

States the common conviction that:

Principle 1

Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations. In this respect, policies promoting or perpetuating apartheid, racial segregation, discrimination, colonial and other forms of oppression and foreign domination stand condemned and must be eliminated.

Principle 2

The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

Principle 3

The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.

Principle 4

Man has a special responsibility to safeguard and wisely manage the heritage of wildlife and its habitat, which are now gravely imperilled by a combination of adverse factors. Nature conservation, including wildlife, must therefore receive importance in planning for economic development.

Principle 5

The non-renewable resources of the earth must be employed in such a way as to guard against the danger of their future exhaustion and to ensure that benefits from such employment are shared by all mankind.

Principle 6

The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the peoples of ill countries against pollution should be supported.

Principle 7

States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle 8

Economic and social development is essential for ensuring a favorable living and working environment for man and for creating conditions on earth that are necessary for the improvement of the quality of life.

Principle 9

Environmental deficiencies generated by the conditions of under-development and natural disasters pose grave problems and can best be remedied by accelerated development through the transfer of substantial quantities of financial and technological assistance as a supplement to the domestic effort of the developing countries and such timely assistance as may be required.

Principle 10

For the developing countries, stability of prices and adequate earnings for primary commodities and raw materials are essential to environmental management, since economic factors as well as ecological processes must be taken into account.

Principle 11

The environmental policies of all States should enhance and not adversely affect the present or future development potential of developing countries, nor should they hamper the attainment

of better living conditions for all, and appropriate steps should be taken by States and international organizations with a view to reaching agreement on meeting the possible national and international economic consequences resulting from the application of environmental measures.

Principle 12

Resources should be made available to preserve and improve the environment, taking into account the circumstances and particular requirements of developing countries and any costs which may emanate-from their incorporating environmental safeguards into their development planning and the need for making available to them, upon their request, additional international technical and financial assistance for this purpose.

Principle 13

In order to achieve a more rational management of resources and thus to improve the environment, States should adopt an integrated and coordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population.

Principle 14

Rational planning constitutes an essential tool for reconciling any conflict between the needs of development and the need to protect and improve the environment.

Principle 15

Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all. In this respect projects which arc designed for colonialist and racist domination must be abandoned.

Principle 16

Demographic policies which are without prejudice to basic human rights and which are deemed appropriate by Governments concerned should be applied in those regions where the rate of population growth or excessive population concentrations are likely to have adverse effects on the environment of the human environment and impede development.

Principle 17

Appropriate national institutions must be entrusted with the task of planning, managing or controlling the 9 environmental resources of States with a view to enhancing environmental quality.

Principle 18

Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind.

Principle 19

Education in environmental matters, for the younger generation as well as adults, giving due consideration to the underprivileged, is essential in order to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises and communities in protecting and improving the environment in its full human dimension. It is also essential that mass media of communications avoid contributing to the deterioration of the environment, but, on the contrary, disseminates information of an educational nature on the need to project and improve the environment in order to enable mal to develop in every respect.

Principle 20

Scientific research and development in the context of environmental problems, both national and multinational, must be promoted in all countries, especially the developing countries. In this connection, the free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems; environmental technologies should be made available to developing countries on terms which would encourage their wide dissemination without constituting an economic burden on the developing countries.

Principle 21

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 22

States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such States to areas beyond their jurisdiction.

Principle 23

Without prejudice to such criteria as may be agreed upon by the international community, or to standards which will have to be determined nationally, it will be essential in all cases to consider the systems of values prevailing in each country, and the extent of the applicability of standards which are valid for the most advanced countries but which may be inappropriate and of unwarranted social cost for the developing countries.

Principle 24

International matters concerning the protection and improvement of the environment should be handled in a cooperative spirit by all countries, big and small, on an equal footing.

Cooperation through multilateral or bilateral arrangements or other appropriate means is essential to effectively control, prevent, reduce and eliminate adverse environmental effects resulting from activities conducted in all spheres, in such a way that due account is taken of the sovereignty and interests of all States.

Principle 25

States shall ensure that international organizations play a coordinated, efficient and dynamic role for the protection and improvement of the environment.

Principle 26

Man and his environment must be spared the effects of nuclear weapons and all other means of mass destruction. States must strive to reach prompt agreement, in the relevant international organs, on the elimination and complete destruction of such weapons.

## Climate change conference timeline

| | |
|---|---|
| **1972 Sweden Stockholm** | |
| First Conference of the UN regaring the issue of environment. | Declare 26 Principles related to the future environment. |
| **1988** | |
| IPCC Established | World Meteorological Organization (WMO) and UN Environment Program UNEP establish the Intergovernmental Panel on Climate Change. |
| **1990** | |
| UN General Assembly | UN General Assembly establishes the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change |
| **1992** | |
| UNFCC Opens for Signature at Rio Earth Summit | The United Nations Framework Convention on Climate Change opens for signature at the Earth Summit in Rio |
| **1994** | |
| UNFCCC Enters into Force | The United Nations Framework Convention on Climate Change, spawned two years earlier in Rio, enters into force. Countries that sign the treaty are known as "Parties". |
| **1995 Germany / Berlin** | |
| First Conference of the Parties (COP1) | The Berlin Mandate establishes a process to negotiate strengthened commitments for developed countries, thus laying the groundwork for the Kyoto Protocol. |
| **1997 Japan / Kyoto** | |
| The third Conference of the Parties | The third Conference of the Parties achieves an historical milestone with adoption of the Kyoto Protocol, the world’s first greenhouse gas emissions reduction treaty. |
| **2001 Germany / Bonn** | |
| The Sixth Conference of the Parties | Governments reaching a broad political agreement on the operational rulebook for the 1997 Kyoto Protocol. |
| **2002 Morocco / Marrakesh** | |
| The Seventh Conference of the Parties | Setting the stage for ratification of the Kyoto Protocol. This would formalize agreement on operational rules for International Emissions Trading, the Clean Development Mechanism and Joint Implementation along with a compliance regime and accounting procedures. |

| **2005** | |
|---|---|
| EU Emissions Trading Launches | The first and largest emissions trading scheme in the world, launches as a major pillar of EU climate policy |
| **2005** | |
| Kyoto Protocol Enters into Force | History is made when the Russian Federation submitted its instrument of ratification to the Kyoto Protocol, sealing its entry into force. |
| **2005 Canada / Montreal** | |
| COP 11 held in conjunction with the first Conference of the Parties serving as the Meeting of the Parties | First time is held in conjunction with the first Conference of the Parties serving as the Meeting of the Parties |
| **2006 Kenia / Nairobi** | |
| COP 12 | The Subsidiary Body for Scientific and Technological Advice SBSTA is mandated to undertake a program to address impacts, vulnerability and adaptation to climate change - the Nairobi Work Program NWP activities are ongoing. |
| **2007 Indonesian / Bali** | |
| COP 13 | The course for a new negotiating process to address climate change. The Plan has five main categories: shared vision, mitigation, adaptation, technology and financing. |
| **2008 Poland /Poznan** | |
| COP 14 | Important steps towards assisting developing countries, including the launch of the Adaptation Fund under the Kyoto Protocol and the Poznan Strategic Program on Technology Transfer. |
| **2009 Denmark /Copenhagen** | |
| COP 15 | Produced the Copenhagen Accord. Developed countries pledge up to USD 30 billion in fast-start finance for the period 2010-2012. |
| **2010 Mexico / Cancun** | |
| COP 16 | A comprehensive package by governments to assist developing nations in dealing with climate change. The Green Climate Fund, the Technology Mechanism and the Cancun Adaptation Framework are established. |
| **2011 South Africa / Durbai** | |
| COP 17 | New universal climate change agreement by 2015 for the period beyond 2020, leading to the launch of the Ad Hoc Working Group on the Durban Platform for Enhanced Action or ADP. |

| 2012 Kata / Doha | |
|---|---|
| COP 18 | Work toward a universal climate change agreement by 2015 and to find ways to scale up efforts before 2020 beyond existing pledges to curb emissions. They also adopt the Doha Amendment, launching a second commitment period of the Kyoto Protocol. |
| **2013 Poland / Warsaw** | |
| COP 19 | Produces the Warsaw Outcomes, including a rulebook for reducing emissions from deforestation and forest degradation and a mechanism to address loss and damage caused by long-term climate change impacts.. |
| **2014 Peru / Lima** | |
| COP 20 | World governments had the opportunity to make a last collective push towards a new and meaningful universal agreement in 2015. |
| **2015 France / Paris** | |
| COP 21 | |

Multiplication factor

Required category - Points evaluation^

**New Points**

# New points distribution

## LEED V4

| **LEED V4 - Existing Criteria** | **Existing Points** | Required category - Points evaluation | Multiplication factor | **New Points** |
|---|---|---|---|---|
| Integrated Process | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Location and Transport** | **16** | | | |
| 1 Sensitive Land Protection | **1** | 1,00 | 5,18 | **5,18** |
| 2 High Priority Site | **2** | 2,00 | 5,18 | **10,36** |
| 3 Surrounding Density and Diverse Uses | **5** | 5,00 | 5,18 | **25,91** |
| 4 Access to Quality Transit | **5** | 5,00 | 5,18 | **25,91** |
| 5 Bicycle Facilities | **1** | 1,00 | 5,18 | **5,18** |
| 6 Reduced Parking Footprint | **1** | 1,00 | 5,18 | **5,18** |
| 7 Green Vehicles | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Sustainable Sites** | **10** | | | |
| 8 Construction Activity Pollution Prevention | **Re.** | 10,00 | 5,18 | **51,81** |
| 9 Site Assessment | **1** | 1,00 | 5,18 | **5,18** |
| 10 Site Development - Protect or Restore Habitat | **2** | 2,00 | 5,18 | **10,36** |
| 11 Open Space | **1** | 1,00 | 5,18 | **5,18** |
| 12 Rainwater Management | **3** | 3,00 | 5,18 | **15,54** |
| 13 Heat Island Reduction | **2** | 2,00 | 5,18 | **10,36** |
| 14 Light Pollution Reduction | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Water Efficiency** | **11** | | | |
| 15 Outdoor Water Use Reduction | **Re.** | 3,67 | 5,18 | **19,00** |
| 16 Indoor Water Use Reduction | **Re.** | 3,67 | 5,18 | **19,00** |
| 17 Building-Level Water Metering | **Re.** | 3,67 | 5,18 | **19,00** |
| 18 Outdoor Water Use Reduction | **2** | 2,00 | 5,18 | **10,36** |
| 19 Indoor Water Use Reduction | **6** | 6,00 | 5,18 | **31,09** |

| | | | | |
|---|---|---|---|---|
| 20 Cooling Tower Water Use | **2** | 2,00 | 5,18 | **10,36** |
| 21 Water Metering | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Energy and Atmosphere** | **33** | | | |
| 22 Fundamental Commissioning and Verification | **Re.** | 8,25 | 5,18 | **42,75** |
| 23 Minimum Energy Performance | **Re.** | 8,25 | 5,18 | **42,75** |
| 24 Building-Level Energy Metering | **Re.** | 8,25 | 5,18 | **42,75** |
| 25 Fundamental Refrigerant Management | **Re.** | 8,25 | 5,18 | **42,75** |
| 26 Enhanced Commissioning | **6** | 6,00 | 5,18 | **31,09** |
| 27 Optimize Energy Performance | **18** | 18,00 | 5,18 | **93,26** |
| 28 Advanced Energy Metering | **1** | 1,00 | 5,18 | **5,18** |
| 29 Demand Response | **2** | 2,00 | 5,18 | **10,36** |
| 30 Renewable Energy Production | **3** | 3,00 | 5,18 | **15,54** |
| 31 Enhanced Refrigerant Management | **1** | 1,00 | 5,18 | **5,18** |
| 32 Green Power and Carbon Offsets | **2** | 2,00 | 5,18 | **10,36** |
| | | | | |
| Materials and Resources | **13** | | | |
| 33 Storage and Collection of Recyclables | **Re.** | 6,50 | 5,18 | **33,68** |
| 34 Construction and Demolition Waste Management Planning | **Re.** | 6,50 | 5,18 | **33,68** |
| 35 Building Life-Cycle Impact Reduction | **5** | 5,00 | 5,18 | **25,91** |
| 36 Building Product Disclosure and Optimization - Environmental Product Declarations | **2** | 2,00 | 5,18 | **10,36** |
| 37 Building Product Disclosure and Optimization – Sourcing of Raw Materials | **2** | 2,00 | 5,18 | **10,36** |
| 38 Building Product Disclosure and Optimization - Material Ingredients | **2** | 2,00 | 5,18 | **10,36** |
| 39 Construction and Demolition Waste Management | **2** | 2,00 | 5,18 | **10,36** |
| | | | | |
| **Indoor Environmental Quality** | **16** | | | |
| 40 Minimum Indoor Air Quality Performance | **Re.** | 8,00 | 5,18 | **41,45** |

| | | | | |
|---|---|---|---|---|
| 41 Environmental Tobacco Smoke Control | **Re.** | 8,00 | 5,18 | **41,45** |
| 42 Enhanced Indoor Air Quality Strategies | **2** | 2,00 | 5,18 | **10,36** |
| 43 Low-Emitting Materials | **3** | 3,00 | 5,18 | **15,54** |
| 44 Construction Indoor Air Quality Management Plan | **1** | 1,00 | 5,18 | **5,18** |
| 45 Indoor Air Quality Assessment | **2** | 2,00 | 5,18 | **10,36** |
| 46 Thermal Comfort | **1** | 1,00 | 5,18 | **5,18** |
| 47 Interior Lighting | **2** | 2,00 | 5,18 | **10,36** |
| 48 Daylight | **3** | 3,00 | 5,18 | **15,54** |
| 49 Quality Views | **1** | 1,00 | 5,18 | **5,18** |
| 50 Acoustic Performance | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Innovation** | **6** | | | |
| 51 Innovation | **5** | 5,00 | 5,18 | **25,91** |
| 52 LEED Accredited Professional | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| **Regional Priority** | **4** | | | |
| 53 Regional Priority: Specific Credit | **1** | 1,00 | 5,18 | **5,18** |
| 53 Regional Priority: Specific Credit | **1** | 1,00 | 5,18 | **5,18** |
| 53 Regional Priority: Specific Credit | **1** | 1,00 | 5,18 | **5,18** |
| 53 Regional Priority: Specific Credit | **1** | 1,00 | 5,18 | **5,18** |
| | | | | |
| TOTAL SCORE | **110** | 193 | | **1000** |

## DGNB

| **DGNB Core 14 - Existing Criteria** | | EVP | RF | **Existing Points** | Multiplication factor | **New Points** |
|---|---|---|---|---|---|---|
| **Environmental Quality** | | | | | | |
| ENV1.1 | Life Cycle Impact Assessment | 10 | 7 | **70** | 1,08 | **75,27** |
| ENV1.2 | Local Environment Impact | 10 | 3 | **30** | 1,08 | **32,26** |
| ENV1.3 | Responsible Procurement | 10 | 1 | **10** | 1,08 | **10,75** |
| ENV2.1 | Life Cycle Impact Assessment – Primary Energy | 10 | 5 | **50** | 1,08 | **53,76** |
| ENV2.2 | Drinking Water Demand and Waster Water Volume | 10 | 2 | **20** | 1,08 | **21,51** |
| ENV2.3 | Land Use | 10 | 2 | **20** | 1,08 | **21,51** |
| **Economic Quality** | | | | | | |
| ECO1.1 | Life Cycle Cost | 10 | 3 | **30** | 1,08 | **32,26** |
| ECO2.1 | Flexibility and adaptability | 10 | 3 | **30** | 1,08 | **32,26** |
| ECO2.2 | Commercial Viability | 10 | 1 | **10** | 1,08 | **10,75** |
| **Sociocultural and Functional Quality** | | | | | | |
| SOC1.1 | Thermal Comfort | 10 | 5 | **50** | 1,08 | **53,76** |
| SOC1.2 | Indoor Air Quality | 10 | 3 | **30** | 1,08 | **32,26** |
| SOC1.3 | Acoustic Comfort | 10 | 1 | **10** | 1,08 | **10,75** |
| SOC1.4 | Visual Comfort | 10 | 3 | **30** | 1,08 | **32,26** |
| SOC1.5 | User Control | 10 | 2 | **20** | 1,08 | **21,51** |
| SOC1.6 | Quality of outdoor spaced | 10 | 1 | **10** | 1,08 | **10,75** |
| SOC1.7 | Safety and Security | 10 | 1 | **10** | 1,08 | **10,75** |
| SOC2.1 | Design for All | 10 | 2 | **20** | 1,08 | **21,51** |
| SOC2.2 | Public Access | 10 | 2 | **20** | 1,08 | **21,51** |
| SOC2.3 | Cyclist Facilities | 10 | 1 | **10** | 1,08 | **10,75** |
| SOC3.1 | Design and Urban Quality | 10 | 2 | **20** | 1,08 | **21,51** |
| SOC3.2 | Integrated Public ART | 10 | 1 | **10** | 1,08 | **10,75** |
| SOC3.3 | Layout Quality | 10 | 1 | **10** | 1,08 | **10,75** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Technical Quality** | | | | | | |
| TEC1.1 | Fire Safety | 10 | 2 | **20** | 1,08 | **21,51** |
| TEC1.2 | Sound Insulation | 10 | 2 | **20** | 1,08 | **21,51** |
| TEC1.3 | Building Envelope Quality | 10 | 2 | **20** | 1,08 | **21,51** |
| TEC1.4 | Adaptability of Technical Systems | 10 | 1 | **10** | 1,08 | **10,75** |
| TEC1.5 | Cleaning and Maintenance | 10 | 2 | **20** | 1,08 | **21,51** |
| TEC1.6 | Deconstruction and Disassembly | 10 | 2 | **20** | 1,08 | **21,51** |
| | | | | | | |
| **Process Quality** | | | | | | |
| PRO1.1 | Comprehensive Project Brief | 10 | 3 | **30** | 1,08 | **32,26** |
| PRO1.2 | Integrated Design | 10 | 3 | **30** | 1,08 | **32,26** |
| PRO1.3 | Design Concept | 10 | 3 | **30** | 1,08 | **32,26** |
| PRO1.4 | Sustainability Aspects in Tender Phase | 10 | 2 | **20** | 1,08 | **21,51** |
| PRO1.5 | Documentation for Facility Management | 10 | 2 | **20** | 1,08 | **21,51** |
| PRO2.1 | Environmental Impact of Construction | 10 | 2 | **20** | 1,08 | **21,51** |
| PRO2.2 | Construction Quality Assurance | 10 | 3 | **30** | 1,08 | **32,26** |
| PRO2.3 | Systematic Commissioning | 10 | 3 | **30** | 1,08 | **32,26** |
| | | | | | | |
| **Site Quality** | | | | | | |
| SITE1.1 | Local Environment | 10 | 2 | **20** | 1,08 | **21,51** |
| SITE1.2 | Public Image and Social Conditions | 10 | 2 | **20** | 1,08 | **21,51** |
| SITE1.3 | Transport Access | 10 | 3 | **30** | 1,08 | **32,26** |
| SITE1.4 | Access to Amenities | 10 | 2 | **20** | 1,08 | **21,51** |
| | | | | | | |
| **TOTAL** | | | | **930** | 1,08 | **1000** |

## ÖGNB

| ÖGNB – TQB Tool 2010 | Existing Points | Multiplic. factor | New Points |
|---|---|---|---|
| **A Location and Facilities** | | | |
| A.1.1 Connection to public transport | 20 | 0,80 | 16,06 |
| A.1.2 Quality of local supply | 20 | 0,80 | 16,06 |
| A.1.3 Quality of social infrastructure | 20 | 0,80 | 16,06 |
| A.1.4 Proximity to recreation areas and recreational facilities | 20 | 0,80 | 16,06 |
| A.2.1 Basic risk of natural hazards | 10 | 0,80 | 8,03 |
| A.2.2 Quality of building land and sealing | 20 | 0,80 | 16,06 |
| A.2.3 Alternating magnetic fields in low frequency range | 10 | 0,80 | 8,03 |
| A.3.1 Interior development | 20 | 0,80 | 16,06 |
| A.3.2 Facilities of building object | 40 | 0,80 | 32,13 |
| A.4.1 Accessibility | 40 | 0,80 | 32,13 |
| **B Economic and Technical Quality** | | | |
| B1.1 Profitability analyses LCCA (Life Cycle Cost Analysis) | 40 | 0,80 | 32,13 |
| B.1.2 Integral Planning and variation analysis | 20 | 0,80 | 16,06 |
| B.1.3 Basis for building operation | 25 | 0,80 | 20,08 |
| B.1.4 Flexibility and durability | 25 | 0,80 | 20,08 |
| B.2.1 Construction site management and logistics | 20 | 0,80 | 16,06 |
| B.2.2. Waste management | 10 | 0,80 | 8,03 |
| B.2.3 Quality of open space | 20 | 0,80 | 16,06 |
| B.3.1 Airtightness of the building | 20 | 0,80 | 16,06 |
| B.3.2 Thermal bridges of the building / humidity protection | 20 | 0,80 | 16,06 |
| B.3.3 Buildings Automation and comfort | 15 | 0,80 | 12,05 |
| B.3.4 Electrostatic floor covering charge | 10 | 0,80 | 8,03 |
| B.3.5 Burglary protection and safety | 10 | 0,80 | 8,03 |
| B.3.6 Special fire extinguisher systems and fire alarm facilities | 15 | 0,80 | 12,05 |

| | | | |
|---|---|---|---|
| B.3.7 Approval building services technology | 15 | 0,80 | 12,05 |
| | | | |
| **C Energy and Supply** | | | |
| C.1.1 Heat consumption HWB | 50 | 0,80 | 40,16 |
| C.1.2 Colling consumption KB | 50 | 0,80 | 40,16 |
| C.1.3 Primary energy demand | 50 | 0,80 | 40,16 |
| C.2.1. Energy-efficient lighting | 30 | 0,80 | 24,10 |
| C.2.2 Enery from photovoltaic | 20 | 0,80 | 16,06 |
| C.3.1 Individual consumption-based biling | 5 | 0,80 | 4,02 |
| C.3.2 Rain water use | 10 | 0,80 | 8,03 |
| C.3.3 Water-saving sanitary facilities | 20 | 0,80 | 16,06 |
| | | | |
| **D Health and Comfort** | | | |
| D.1.1 Thermal comfort in winter | 15 | 0,80 | 12,05 |
| D.1.2 Thermal comfort in summer | 45 | 0,80 | 36,14 |
| D.2.1 Ventilation | 30 | 0,80 | 24,10 |
| D.2.2 Low emission and low pollutant construction materials in interior fittings | 40 | 0,80 | 32,13 |
| D.2.3 Mold and moisture prevention / Pollution inspection | 10 | 0,80 | 8,03 |
| D.3.1 Ambient noise simulation | 15 | 0,80 | 12,05 |
| D.3.2 Room acoustics | 15 | 0,80 | 12,05 |
| D.3.3 Noise protection of partition components between buildings units | 15 | 0,80 | 12,05 |
| D.3.4 Impact sound protection of partition ceilings between building units | 15 | 0,80 | 12,05 |
| D.3.5 Continuos nois level inside / facilitiy noise level | 15 | 0,80 | 12,05 |
| D.4.1 Quality of the artificial light | 20 | 0,80 | 16,06 |
| D.4.2 Daylight factor | 20 | 0,80 | 16,06 |
| D.4.3 Sun and glare protection | 25 | 0,80 | 20,08 |
| | | | |
| **E Resource efficiency** | | | |
| E.1.1 Avoidance of CFC | 15 | 0,80 | 12,05 |
| E.1.2 Avoidance of PVC | 45 | 0,80 | 36,14 |
| E.2.1 Use of regional products | 20 | 0,80 | 16,06 |

| | | | |
|---|---|---|---|
| E.2.2 Use of recycling material | 20 | 0,80 | 16,06 |
| E.2.3 Use of products with environmental certificates | 25 | 0,80 | 20,08 |
| E.3.1 O13 Calculation as leading indicator for eco efficiency of the building | 60 | 0,80 | 48,19 |
| E.4.1 Disposal indicator | 60 | 0,80 | 48,19 |
| **TOTAL** | **1245** | | **1000** |

## GBEL

| **GBEL GB/T 50378-2014** | **EXP** | PRI | VAI | MX x VAI | MF | **NP** |
|---|---|---|---|---|---|---|
| **4. Land Saving and Outdoor Environment** | | | | | | |
| 4.1 Prerequisite Items | | | | | | |
| 4.1.1 The site selection accords with local urban plan and meet the construction control requirements of preserved area, historical sites and cultural relics. | | **25,00** | 0,13 | 3,25 | 5,00 | **16,25** |
| 4.1.2 The selected site is free from threat as flood, landslide, and radon-containing soil, and within the safe range of the building site. There are no dangerous sources as hazardous chemicals, flammable explosive hazard and electromagnetic radiation danger. | | **25,00** | 0,13 | 3,25 | 5,00 | **16,25** |
| 4.1.3 There is no pollution sources exceeding the discharging standard within the site. | | **25,00** | 0,13 | 3,25 | 5,00 | **16,25** |
| 4.1.4The architectural layout of the site meets the daylight standard and does not decrease the daylight level of the surroundings. | | **25,00** | 0,13 | 3,25 | 5,00 | **16,25** |
| 4.2 Scoring Items | | | | | | |
| 4.2.1. Land use saving | **19** | 19,00 | 0,13 | 2,47 | 5,00 | **12,35** |
| 4.2.2Greening rate and accessibility | **9** | 9,00 | 0,13 | 1,17 | 5,00 | **5,85** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.2.3 Underground space development | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| 4.2.4 Light pollution prevention | **4** | 4,00 | 0,13 | 0,52 | 5,00 | **2,60** |
| 4.2.5 Site Noise | **4** | 4,00 | 0,13 | 0,52 | 5,00 | **2,60** |
| 4.2.6 Site wind environment | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| 4.2.7Heat island intensity reduction | **4** | 4,00 | 0,13 | 0,52 | 5,00 | **2,60** |
| 4.2.8 Public transportation access | **9** | 9,00 | 0,13 | 1,17 | 5,00 | **5,85** |
| 4.2.9 Accessible design | **3** | 3,00 | 0,13 | 0,39 | 5,00 | **1,95** |
| 4.2.10Parking area plan | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| 4.2.11 Accessible public service | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| 4.2.12 Site ecology conservation | **3** | 3,00 | 0,13 | 0,39 | 5,00 | **1,95** |
| 4.2.13 Green rainwater facilities | **9** | 9,00 | 0,13 | 1,17 | 5,00 | **5,85** |
| 4.2.14 Runoof control | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| 4.2.15 Reasonable greening | **6** | 6,00 | 0,13 | 0,78 | 5,00 | **3,90** |
| | | | | | | |
| **5. Energy Saving and Energy Utilization** | | | | | | |
| 5.1 Prerequisite Items | | | | | | |
| 5.1.1 Building design complies with the mandatory provisions in the existing national standards for building energy saving. | | **25,00** | 0,23 | 5,75 | 5,00 | **28,75** |
| 5.1.2 The electric heating installations is not used directly as the heat source of air conditioning or heat source of air humidification system. | | **25,00** | 0,23 | 5,75 | 5,00 | **28,75** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5.1.3 Measure energy consumption of chill-heat source, distribution system and lighting system independently. | | **25,00** | 0,23 | 5,75 | 5,00 | **28,75** |
| 5.1.4 The lighting power density for each room or spaces does not exceed the specified values in existing national standard "Standard for Lighting Design of Buildings" GB 50034 | | **25,00** | 0,23 | 5,75 | 5,00 | **28,75** |
| 5.2 Scoring Item | | | | | | |
| 5.2.1 Overall plan & orientation | **6** | 6,00 | 0,23 | 1,38 | 5,00 | **6,90** |
| 5.2.2 Openable area of facade | **6** | 6,00 | 0,23 | 1,38 | 5,00 | **6,90** |
| 5.2.3 Thermal performance optimization of building envelope | **10** | 10,00 | 0,23 | 2,30 | 5,00 | **11,50** |
| 5.2.4 Chill heat source units energy efficiency optimization | **6** | 6,00 | 0,23 | 1,38 | 5,00 | **6,90** |
| 5.2.5 Electricity consumption reduction on circulation pump | **6** | 6,00 | 0,23 | 1,38 | 5,00 | **6,90** |
| 5.2.6 HVAC efficiency | **10** | 10,00 | 0,23 | 2,30 | 5,00 | **11,50** |
| 5.2.7 Transition season measure | **6** | 6,00 | 0,23 | 1,38 | 5,00 | **6,90** |
| 5.2.8 Partial load reduction measures | **9** | 9,00 | 0,23 | 2,07 | 5,00 | **10,35** |
| 5.2.9 Illuminiating system energy-saving control | **5** | 5,00 | 0,23 | 1,15 | 5,00 | **5,75** |
| 5.2.10 illumination power density | **8** | 8,00 | 0,23 | 1,84 | 5,00 | **9,20** |
| 5.2.11 Elevator energy saving | **3** | 3,00 | 0,23 | 0,69 | 5,00 | **3,45** |
| 5.2.12 Energy saving electrical equipment | **5** | 5,00 | 0,23 | 1,15 | 5,00 | **5,75** |
| 5.2.13Heat recovery | **3** | 3,00 | 0,23 | 0,69 | 5,00 | **3,45** |
| 5.2.14 Cold storage | **3** | 3,00 | 0,23 | 0,69 | 5,00 | **3,45** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5.2.15 Waste heat utilization | **4** | 4,00 | 0,23 | 0,92 | 5,00 | **4,60** |
| 5.2.16 Reneable energy utilization | **10** | 10,00 | 0,23 | 2,30 | 5,00 | **11,50** |
| **6. Water Saving and Water Resource Utilization** | | | | | | |
| 6.1 Prerequisite Item | | | | | | |
| 6.1.1Make utilization plan for water resource. Utilize and plan all water resources as a whole. | | **33,33** | 0,14 | 4,67 | 5,00 | **23,33** |
| 6.1.2 Design water supply and drainage system reasonably, optimally and safely. | | **33,33** | 0,14 | 4,67 | 5,00 | **23,33** |
| 6.1.3 Use water-saving appliances. | | **33,33** | 0,14 | 4,67 | 5,00 | **23,33** |
| 6.2 Scoring Items | | | | | | |
| 6.2.1 Water consumption limits | **10** | 10,00 | 0,14 | 1,40 | 5,00 | **7,00** |
| 6.2.2 Pipe network leakage avoidance | **7** | 7,00 | 0,14 | 0,98 | 5,00 | **4,90** |
| 6.2.3 Overall pressure discharge free | **8** | 8,00 | 0,14 | 1,12 | 5,00 | **5,60** |
| 6.2.4 Water metering | **6** | 6,00 | 0,14 | 0,84 | 5,00 | **4,20** |
| 6.2.5 Public water saving measures | **4** | 4,00 | 0,14 | 0,56 | 5,00 | **2,80** |
| 6.2.6 High water use efficiency sanitary device | **10** | 10,00 | 0,14 | 1,40 | 5,00 | **7,00** |
| 6.2.7 Water saving irrigation system | **10** | 10,00 | 0,14 | 1,40 | 5,00 | **7,00** |
| 6.2.8Water saving cooling echnology for Air conditioning | **10** | 10,00 | 0,14 | 1,40 | 5,00 | **7,00** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6.2.9 Other water saving technologies | **5** | 5,00 | 0,14 | 0,70 | 5,00 | **3,50** |
| 6.2.10 Non-traditional water source use | **15** | 15,00 | 0,14 | 2,10 | 5,00 | **10,50** |
| 6.2.11 Cooling water supplement | **8** | 8,00 | 0,14 | 1,12 | 5,00 | **5,60** |
| 6.2.12 Landscape waterig system | **7** | 7,00 | 0,14 | 0,98 | 5,00 | **4,90** |
| | | | | | | |
| **7. Material Saving and Material Resource Utilization** | | | | | | |
| 7.1 Prerequisite Items | | | | | | |
| 7.1.1 Construction materials and products prohibited and restricted by local and national government must not be used. | | **33,33** | 0,15 | 5,00 | 5,00 | **25,00** |
| 7.1.2 Use hot rolled ribbed steel bar no less than 400 Mpa as bearing force reinforcement bars for beams and columns of concrete structure | | **33,33** | 0,15 | 5,00 | 5,00 | **25,00** |
| 7.1.3 The outline of the building is excessive decorating member. | | **33,33** | 0,15 | 5,00 | 5,00 | **25,00** |
| | | | | | | |
| 7.2 Scoring Items | | | | | | |
| 7.2.1 Architectural and structural form regularity | **9** | 9,00 | 0,15 | 1,35 | 5,00 | **6,75** |
| 7.2.2 Optimized structure design | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| 7.2.3 Integrated civil engineering and decoration work | **10** | 10,00 | 0,15 | 1,50 | 5,00 | **7,50** |
| 7.2.4 Transformable indoor spaces percentage | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| 7.2.5 Prefabricated elements use precentage | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7.2.6 Integrated kitchen and toilet design | **6** | 6,00 | 0,15 | 0,90 | 5,00 | **4,50** |
| 7.2.7 Locally produced material | **10** | 10,00 | 0,15 | 1,50 | 5,00 | **7,50** |
| 7.2.8 Ready mixed concrete | **10** | 10,00 | 0,15 | 1,50 | 5,00 | **7,50** |
| 7.2.9 Ready mixed mortat | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| 7.2.10 High strenght structure material | **10** | 10,00 | 0,15 | 1,50 | 5,00 | **7,50** |
| 7.2.11 High-durability material | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| 7.2.12 Reusable and recycleable material | **10** | 10,00 | 0,15 | 1,50 | 5,00 | **7,50** |
| 7.2.13 Waste material utilization | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| 7.2.14 Durable decoration materials | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| | | | | | | |
| **8. Indoor Environment Quality** | | | | | | |
| 8.1 Prerequisite Items | | | | | | |
| 8.1.1 The indoor noise level of regularly occupied rooms reaches the lower limits in the existing national standard “Code for design of sound insulation of civil buildings” GB 50118. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.1.2 The sound insulation performance of exterior wall, partition, floor, door and window of regularly occupied rooms reaches the lower limits in the existing national standard “Code for design of sound insulation of civil buildings” GB 50118. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8.1.3 The quantity and quality of building lightings conform to the existing national standard “Standard for lighting design of buildings” GB 50034. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.1.4 For buildings with central heating and air-conditioning systems, design parameters as room temperature, humidity, and fresh air volume accord with the existing national standard “Design code for heating ventilation and air conditioning of civil buildings” | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.1.5 No condensation exists at the inner surface of building envelope with indoor design temperature and humidity. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.1.6 Thermal insulation performance of roofs, east and west exterior walls meets the requirements in the existing national standard “Thermal design code for civil buildings” GB 50176. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.1.7 The concentration of indoor air pollutants such as ammonia, formaldehyde, benzene, and TVOC accords with values in the existing national standard “Indoor air quality standard” GB/T 18883. | | **14,29** | 0,15 | 2,14 | 5,00 | **10,71** |
| 8.2.1 Interior noise level (Voluntary) | **6** | 6,00 | 0,15 | 0,90 | 5,00 | **4,50** |
| 8.2.2Sounds insulation performance (Voluntary) | **9** | 9,00 | 0,15 | 1,35 | 5,00 | **6,75** |
| 8.2.3 Noise interference reduction | **4** | 4,00 | 0,15 | 0,60 | 5,00 | **3,00** |
| 8.2.4 Special acoustic design | **3** | 3,00 | 0,15 | 0,45 | 5,00 | **2,25** |
| 8.2.5 Vision | **3** | 3,00 | 0,15 | 0,45 | 5,00 | **2,25** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8.2.6 Daylight factor | **8** | 8,00 | 0,15 | 1,20 | 5,00 | **6,00** |
| 8.2.7 Indoor daylight improvement | **14** | 14,00 | 0,15 | 2,10 | 5,00 | **10,50** |
| 8.2.8 Adjustable sunshades | **12** | 12,00 | 0,15 | 1,80 | 5,00 | **9,00** |
| 8.2.9 Heating and air conditioning adjustable terminals | **8** | 8,00 | 0,15 | 1,20 | 5,00 | **6,00** |
| 8.2.10 Natural verntilation optimization | **13** | 13,00 | 0,15 | 1,95 | 5,00 | **9,75** |
| 8.2.11 Reasonable Air distribution | **7** | 7,00 | 0,15 | 1,05 | 5,00 | **5,25** |
| 8.2.12 Indoor air uality monitoring | **8** | 8,00 | 0,15 | 1,20 | 5,00 | **6,00** |
| 8.2.13 Underground garages exhauste air monitoring | **5** | 5,00 | 0,15 | 0,75 | 5,00 | **3,75** |
| | | | | | | |
| **9. Construction Management** | | | | | | |
| 9.1 Prerequisite Items | | | | | | |
| 9.1.1 Establish construction management system and framework for sustainable building project. Claim responsibility at levels | | **25,00** | 0,1 | 2,50 | 5,00 | **12,50** |
| 9.1.2 Develop and implement environment protection plan for the whole construction process by project management department. | | **25,00** | 0,1 | 2,50 | 5,00 | **12,50** |
| 9.1.3 Make and implement health and safety management plan for constructors by project management department. | | **25,00** | 0,1 | 2,50 | 5,00 | **12,50** |
| 9.1.4 Arrange joint conference on key technology of sustainable building design plan before construction. | | **25,00** | 0,1 | 2,50 | 5,00 | **12,50** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9.2 Scoring Itmes | | | | | | |
| 9.2.1 Dust reduction | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 9.2.2 Noise reduction | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 9.2.3 Waste reduction | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| 9.2.4 Construction energy saving plan | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| 9.2.5 Water saving and consumption plan | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| 9.2.6 Ready mix concrete loss reduction | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 9.2.7 Reinforced iron loss reduction | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| 9.2.8 Set shaped steel framework | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| 9.2.9 Design document implementation | **4** | 4,00 | 0,1 | 0,40 | 5,00 | **2,00** |
| 9.2.10 Design change documents control | **4** | 4,00 | 0,1 | 0,40 | 5,00 | **2,00** |
| 9.2.11 Ensuring building durability | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| 9.2.12 Integration of civil and decoration constructin | **14** | 14,00 | 0,1 | 1,40 | 5,00 | **7,00** |
| 9.2.13 Debugging and test of mechanical amd electrical system | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| | | | | | | |
| **10. Operation Management** | | | | | | |
| 10.1 Prerequisite Items | | | | | | |
| 10.1.1 Make and implement management system of energy saving, water saving, material saving and greening | | **20,00** | 0,1 | 2,00 | 5,00 | **10,00** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10.1.2 Make waste manage system. Plan waste transportation properly. Collect and classified domestic waste. Plan waste container properly. | | **20,00** | 0,1 | 2,00 | 5,00 | **10,00** |
| 10.1.3 Contaminants as waste gas and waste water emitted during operation meet the standard. | | **20,00** | 0,1 | 2,00 | 5,00 | **10,00** |
| 10.1.4 Energy-saving facilities and water-saving facilities meet design requirements and work properly. | | **20,00** | 0,1 | 2,00 | 5,00 | **10,00** |
| Monitoring system of heating, ventilation, air conditioning and lighting etc. works properly and the operation condition is completely recorded | | **20,00** | 0,1 | 2,00 | 5,00 | **10,00** |
| 7.2 Scoring Items | | | | | | |
| 10.2.1 Certified Property management agencies | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| 10.2.2 Operation procedures and emergency response system | **8** | 8,00 | 0,1 | 0,80 | 5,00 | **4,00** |
| 10.2.3 Energy saving operation incentive mechanism | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 10.2.4 Green education and publicity mechanism | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 10.2.5 Inspection and optimizatin of public facilities and equipment | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| 10.2.6 Inspection and cleaning of air conditioning and ventilatin system | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 10.2.7 Non trading water source quality monitoring | **4** | 4,00 | 0,1 | 0,40 | 5,00 | **2,00** |
| 10.2.8 Intelligent system effectiveness | **12** | 12,00 | 0,1 | 1,20 | 5,00 | **6,00** |
| 10.2.9 Property information management | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| 10.2.10 Pollution free diseases and insects control techniques | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 10.2.11 Trees survival rate | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10.2.12 Garbage collection statin stink free | **6** | 6,00 | 0,1 | 0,60 | 5,00 | **3,00** |
| 10.2.13 Categorized garbage collection and processing | **10** | 10,00 | 0,1 | 1,00 | 5,00 | **5,00** |
| **TOTAL** | **700** | 1400,00 | | 200,00 | 5,00 | **1000,00** |
| **11. Innovation** | | | | | | |
| 11.2 Bonus Items | | | | | | |
| 11.2.1 Thermal performance optimization of building envelope | **2** | 2,00 | | | | |
| 11.2.2 Efficiency of cold and heat source units | **1** | 1,00 | | | | |
| 11.2.3 Distributed energy supply | **1** | 1,00 | | | | |
| 11.2.4 Level 1 water saving devices | **1** | 1,00 | | | | |
| 11.2.5 Special structure system | **1** | 1,00 | | | | |
| 11.2.6 Air purification device | **1** | 1,00 | | | | |
| 11.2.7 Decrease of pollutant concentration | **1** | 1,00 | | | | |
| 11.2.8 Innovative building plan | **2** | 2,00 | | | | |
| 11.2.9 Utilization of abandoned land | **1** | 1,00 | | | | |
| 11.2.10 BIM Design, Construction & Operation | **1** | 1,00 | | | | |
| 11.2.11 Calculation of carbon emission | **1** | 1,00 | | | | |
| 11.2.12 Other innovation strategies | **2** | | | | | |

# Appendix II

## Criteria Catalog LEED V4

**INTEGRATED PLANING PROCESS**

| | |
|---|---|
| 00 | Integrated Process<br>To support high-performance, cost-effective project outcomes through an early analysis of the interrelationships among systems. |

**LOCATION AND TRANSPORT**

| | |
|---|---|
| 01a | LEED for Neighborhood Development Location<br>To avoid development on inappropriate sites. To reduce vehicles miles traveled. To enhance livability and improve human health by encouraging daily physical activity. |
| 01b | Sensitive Land Protection<br>To avoid the development of environmentally sensitive lands and reduce the environmental impact from the location of a building on a site. |
| 02 | High Priority Site<br>To encourage project location in areas with development constraints and promote the health of the surrounding area. |
| 03 | Surrounding Density and Diverse Uses<br>To conserve land and protect farmland and wildlife habitat by encouraging development in areas with existing infrastructure. To promote walkability, and transportation efficiency and reduce vehicle distance traveled. To improve public health by encouraging daily physical activity. |
| 04 | Access to Quality Transit<br>To encourage development in locations shown to have multimodal transportation choices or otherwise reduced motor vehicle use, thereby reducing greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use. |
| 05 | Bicycle Facilities |

| | |
|---|---|
| | To promote bicycling and transportation efficiency and reduce vehicle distance traveled. To improve public health by encouraging utilitarian and recreational physical activity. |
| 06 | Reduced Parking Footprint |
| | To minimize the environmental harms associated with parking facilities, including automobile dependence, land consumption, and rainwater runoff. |
| 07 | Green Vehicles |
| | To reduce pollution by promoting alternatives to conventionally fueled automobiles. |
| **SUSTAINABLE SITE** | |
| 08 | Construction Activity Pollution Prevention |
| | To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust. |
| 09 | Site Assessment |
| | To assess site conditions before design to evaluate sustainable options and inform related decisions about site design. |
| 10 | Site Development - Protect or Restore Habitat |
| | To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. |
| 11 | Open Space |
| | To create exterior open space that encourages interaction with the environment, social interaction, passive recreation, and physical activities. |
| 12 | Rainwater Management |
| | To reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site, based on historical conditions and undeveloped ecosystems in the region. |
| 13 | Heat Island Reduction |
| | To minimize effects on microclimates and human and wildlife habitats by reducing heat islands |
| 14 | Light Pollution Reduction |
| | To increase night sky access, improve nighttime visibility, and reduce the consequences of development for wildlife and people. |
| **WATER EFFICIENCY** | |
| 15 | Outdoor Water Use Reduction |

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| | To reduce outdoor water consumption. |
| 16 | Indoor Water Use Reduction |
| | To reduce indoor water consumption. |
| 17 | Building-Level Water Metering |
| | To support water management and identify opportunities for additional water savings by tracking water consumption. |
| 18 | Outdoor Water Use Reduction |
| | To reduce outdoor water consumption. |
| 19 | Indoor Water Use Reduction |
| | To reduce indoor water consumption. |
| 20 | Cooling Tower Water Use |
| | To conserve water used for cooling tower makeup while controlling microbes, corrosion, and scale in the condenser water system. |
| 21 | Water Metering |
| | To support water management and identify opportunities for additional water savings by tracking water consumption. |
| **ENERGY AND ATMOSPHERE** | |
| 22 | Fundamental Commissioning and Verification |
| | To support the design, construction, and eventual operation of a project that meets the owner's project requirements for energy, water, indoor environmental quality, and durability. |
| 23 | Minimum Energy Performance |
| | To reduce the environmental and economic harms of excessive energy use by achieving a minimum level of energy efficiency for the building and its systems. |
| 24 | Building-Level Energy Metering |
| | To support energy management and identify opportunities for additional energy savings by tracking building-level energy use. |
| 25 | Fundamental Refrigerant Management |
| | To reduce stratospheric ozone depletion. |
| 26 | Enhanced Commissioning |
| | To further support the design, construction, and eventual operation of a project that meets the owner's project requirements for energy, water, indoor environmental quality, and durability. |

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| 27 | Optimize Energy Performance<br><br>To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic harms associated with excessive energy use. |
| 28 | Advanced Energy Metering<br><br>To support energy management and identify opportunities for additional energy savings by tracking building-level and system-level energy use. |
| 29 | Demand Response<br><br>To increase participation in demand response technologies and programs that make energy generation and distribution systems more efficient, increase grid reliability, and reduce greenhouse gas emissions. |
| 30 | Renewable Energy Production<br><br>To reduce the environmental and economic harms associated with fossil fuel energy by increasing self-supply of renewable energy. |
| 31 | Enhanced Refrigerant Management<br><br>To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change. |
| 32 | Green Power and Carbon Offsets<br><br>To encourage the reduction of greenhouse gas emissions through the use of grid-source, renewable energy technologies and carbon mitigation projects. |
| **MATERIAL AND RESOURCES** | |
| 33 | Storage and Collection of Recyclables<br><br>To reduce the waste that is generated by building occupants and hauled to and disposed of in landfills. |
| 34 | Construction and Demolition Waste Management Planning<br><br>To reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials. |
| 35 | Building Life-Cycle Impact Reduction<br><br>To encourage adaptive reuse and optimize the environmental performance of products and materials. |
| 36 | Building Product Disclosure and Optimization - Environmental Product Declarations<br><br>To encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and |

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| | socially preferable life-cycle impacts. To reward project teams for selecting products from manufacturers who have verified improved environmental life-cycle impacts. |
| 37 | Building Product Disclosure and Optimization - Sourcing of Raw Materials<br><br>To encourage the use of products and materials for which life cycle information is available and that have environmentally, economically, and socially preferable life cycle impacts. To reward project teams for selecting products verified to have been extracted or sourced in a responsible manner. |
| 38 | Building Product Disclosure and Optimization - Material Ingredients<br><br>To encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts. To reward project teams for selecting products for which the chemical ingredients in the product are inventoried using an accepted methodology and for selecting products verified to minimize the use and generation of harmful substances. To reward raw material manufacturers who produce products verified to have improved life-cycle impacts. |
| 39 | Construction and Demolition Waste Management<br><br>To reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials. |
| **INDOOR ENVIRONMENTAL QUALITY** | |
| 40 | Minimum Indoor Air Quality Performance<br><br>To contribute to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality (IAQ). |
| 41 | Environmental Tobacco Smoke Control<br><br>To prevent or minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to environmental tobacco smoke. |
| 42 | Enhanced Indoor Air Quality Strategies<br><br>To promote occupants' comfort, well-being, and productivity by improving indoor air quality. |
| 43 | Low-Emitting Materials<br><br>To reduce concentrations of chemical contaminants that can damage air quality, human health, productivity, and the environment. |
| 44 | Construction Indoor Air Quality Management Plan |

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| | To promote the well-being of construction workers and building occupants by minimizing indoor air quality problems associated with construction and renovation. |
| 45 | Indoor Air Quality Assessment |
| | To establish better quality indoor air in the building after construction and during occupancy. |
| 46 | Thermal Comfort |
| | To promote occupants' productivity, comfort, and well-being by providing quality thermal comfort. |
| 47 | Interior Lighting |
| | To promote occupants' productivity, comfort, and well-being by providing high-quality lighting. |
| 48 | Daylight |
| | To connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space. |
| 49 | Quality Views |
| | To give building occupants a connection to the natural outdoor environment by providing quality views. |
| 50 | Acoustic Performance |
| | To provide workspaces and classrooms that promote occupants' well-being, productivity, and communications through effective acoustic design. |
| **INNOVATION** | |
| 51 | Innovation |
| | To encourage projects to achieve exceptional or innovative performance. |
| 52 | LEED Accredited Professional |
| | To encourage the team integration required by a LEED project and to streamline the application and certification process. |
| **REGIONAL PRIORITY** | |
| 53-56 | Regional Priority: Specific Credit |
| | To provide an incentive for the achievement of credits that address geographically specific environmental, social equity, and public health priorities. |

# Criteria Catalog DGNB Core 14

**ENVIRONMENTAL QUALITY**

ENV1.1 Life Cycle Impact Assessment

Buildings generate emissions in all phases of their life cycle, from manufacture through use up to their end of life. These emissions travel into the air, the water, and the soil where they cause a range of environmental issues. These include global warming, depletion of the stratospheric ozone layer, summer smog, dying forest trees and fresh water fish, and the eutrophication of water and soils. The objective is therefore to reduce buildings' emissions throughout their entire life cycle as much as possible

ENV1.2 Local Environment Impact

Certain materials, products and methods are hazardous to soil, air, ground, and surface water as well as the health of humans, flora, and fauna. The use of materials, products, and methods which endanger the soil, air, ground, and surface water due to their chemical composition or physical characteristics must be reduced or avoided, or these must be substituted in order to reduce risks to humans and to the local environment to a minimum. This applies particularly to those materials, products, and methods which cause short, medium and/or long-term damage to risks to soil, air, ground, and surface water as well as the health of humans, flora, and fauna. This includes a consideration of their entire life cycle including manufacture and processing on the building site, use in the building, and their end-of-life including demolition, recycling, and disposal. Risks to the local environment are considered in relation to materials and products used. At present, there are no established methods to capture and evaluate toxicity to humans and the environment.

ENV1.3 Responsible Procurement

This criterion supports the use of materials sourced and finished in accordance with recognized social and environmental standards. Its objective is to protect forests, exclude child labor, and maintain social and environmental standards in quarrying natural stone. The use of certified timber and timber based materials supports sustainable forestry and the preservation of existing forests. Compliance with recognized standards in natural stone treatment improves working conditions in quarries and in finishing in developing and emerging economies.

ENV2.1 Life Cycle Impact Assessment – Primary Energy

The criterion evaluates the complete primary energy requirement of a building. Here particular value is placed on the reduction of the overall consumption of primary energy and the maximization of the use of renewable energies. Here the objective is over fulfilment of the legal regulations to the benefit of global protection of the climate and resources.

ENV2.2 Drinking Water Demand and Waste Water Volume

Water is extracted from natural circuits on a daily basis and processed at length in order to obtain high-quality drinking water. The corresponding waste water must subsequently be treated so that harmful substances and contaminants are removed before it is returned to the natural water circuit. The aim is therefore to disturb the natural water circuit as little as possible by reducing the demand for drinking water and the volume of waste water.

ENV2.3 Land Use

This criterion evaluates the building's space consumption. Its aim is to reduce the space consumed by settlement and highway infrastructure and to prevent further greenfield sprawl. This is aimed at reducing the proportion of the earth's surfaces that is sealed and made impermeable, thereby preventing rainwater infiltration (e.g. through asphalt and concrete surfacing). Existing sealed areas should be replaced by permeable surfacing inasmuch as possible. Maximum use should be made of sites already prepared for development

**ECONOMIC QUALITY**

ECO1.1 Life Cycle Cost

Costs arise throughout a building's life cycle: from construction, through operation and maintenance, to demolition. From an economic perspective, the aim is to reduce the building's total life cycle costs (LCC) to a minimum. The objective of the LCC analysis in certification is to facilitate a comparison between different buildings with the same use. This requires clear rules for identifying and documenting building costs as well as comparable benchmarks for their evaluation. These rules create clear parameters which allow evaluations of different buildings with the same use to be compared. In order to focus on construction-based LCC, the evaluation is based on certain key costs categories which are calculated for a pre-defined study period.

ECO2.1 Flexibility and adaptability

The ease with which a building can be adapted to changing requirements helps raise user satisfaction; it can prolong the building's service life and lower costs incurred throughout its life cycle. Flexibility and adaptability reduce the risk of vacancy and can contribute to buildings long-term economic success.
Hence this criterion is aimed at making the building's design as flexible as possible and creating the greatest possible potential for reuse.

ECO2.2 Commercial Viability

The economy is one of the three pillars of sustainability. It comprises all of the facilities and processes which address our needs, whether by producing and distributing goods or by providing services. This includes buildings: depending on their use, they serve to house people or provide space for work, shopping, and leisure etc. Unused buildings represent a misallocation of economic resources, and medium or long-term building vacancies are not sustainable. Thus the aim of this criterion is to assess whether a building has the potential to respond to medium and long-term user demand in the relevant market.

## SOCIOCULTURAL AND FUNCTIONAL QUALITY

SOC1.1 Thermal Comfort

Thermal comfort in buildings makes an important contribution to an efficient and performance-enhancing working and living environment. A room is deemed to be thermally comfortable if it is neither too cold nor too warm, the air neither too dry nor too moist, and there is no draught.

SOC1.2 Indoor Air Quality

The aim of the criterion is to ensure that indoor air is of sufficient quality not to adversely affect users' health and well-being. To this end, it is particularly important to establish hygiene, to reduce the concentration of harmful substances, and to prevent unpleasant smells. TVOC concentrations exceeding 3.000 $\mu g/m^3$, formaldehyde concentrations exceeding 120 $\mu g/m^3$, or the transgression of Guide value 2 (defined by the German Environment Ministry' Ad-hoc Working Group for Indoor Air Guide Values) endanger hygiene of rooms in dwellings, offices or teaching rooms used by the same persons for several hours. For this reason, buildings with these high pollution levels are excluded from certification. In rooms where occupants stay only for few hours and change on a continuous basis (e.g. sales rooms, film screening rooms) , appropriate methods must be applied to reduce the above mentioned danger to hygiene to the lowest possible level. Buildings presenting an identifiable risk to health must be excluded from certification. Rooms where surrounding building components present only a limited threat and rooms which are not used on a continuous basis (e.g. large sheds or warehouses) present a limited risk to health. The objective is for building materials and methods in rooms of this type to present only limited pollution levels.

SOC1.3 Acoustic Comfort

Good acoustic conditions are an important requirement for the performance and comfort of the users. The objective of the criterion is thus to achieve room acoustic conditions which are appropriate for the intended use and which guarantee a sufficient level of user comfort.

SOC1.4 Visual Comfort

User satisfaction is closely linked to the user's sense of comfort. The supply of daylight to the interior plays a particularly significant role here. Natural light has a positive effect on people's physical and mental health. For this reason, it is necessary to ensure an adequate and uninterrupted supply of daylight and artificial light in all interior areas in constant use.

SOC1.5 User Control

Both the building’s energy consumption and the productivity of people working in it are closely linked to user‘s options to control the indoor climate. Thermal comfort, indoor air quality, noise levels and lighting are important factors contributing to user satisfaction. This criterion aims to provide occupants with the best possible options to control ventilation, to protect themselves from excessive sunlight and glare, to control the temperature (both during and outside the heating period), and to control daylight and artificial lighting.

SOC1.6 Quality of outdoor spaced

External recreational areas close to the building enhance the general well-being of the user, provide alternative working and rest areas, encourage interaction between the users and increase the general acceptance of the structure. The external areas can also contribute to improving the urban image and the microclimate if designed accordingly.

SOC1.7 Safety and Security

A high sense of security makes a vital contribution to people's comfort. By contrast, uncertainty and anxiety restrict freedom of movement. Measures which increase the sense of security are generally also suitable for reducing the danger of attack by other people. The aim is to prevent dangerous situations as much as possible and to limit the impact of potential natural disasters as much as possible.

SOC2.1 Design for All

The greatest possible level of accessibility to both the inner area and the associated external areas adds toa building’s utility. Design for all is a significant component of a pioneering and sustainable development in construction. The aim is to make the complete built environment available to every person without obstacle and in principle without external assistance. This makes it possible for disabled people to lead independent lives and to participate fully in all aspects of life.

SOC2.2 Public Access

Buildings which offer good public access and a wide range of uses integrate better into the urban context and are more likely to meet with public approval. Public access encourages communication and gives something back to the wider community. A wide range of uses enlivens the public area and supports a vibrant community as well as contributing to public approval for the building and integrating the building and its associated open spaces into the urban fabric. At the same time these factors increase users' sense of security and contribute to the economic sustainability of the building.

SOC2.3 Cyclist Facilities

Cycling is a significant component of environmentally friendly personal transport. The aim is thus to encourage and support the use of bicycles. An important pre-requisite for this is an adequate number of bicycle parking areas of suitable quality on the premises. This increases the level of user acceptance and prevents uncontrolled parking of the bicycles in the public area.

SOC3.1 Design and Urban Quality

Competitions are a tried and tested method for the procurement of design services. Competitive processes help identify and achieve the best possible solution for the architectural and structural challenges of the project brief. In addition to this, competitions also contribute to a rich and diverse building culture.

SOC3.2 Integrated Public ART

Art in buildings creates a direct link between the public, the building, and the uses it accommodates. Art can capture the public's attention and help it identify with a building. Art can also strengthen local identity and foster public approval.

Art in buildings may be integral to the fabric of the building or located elsewhere on the site and there is no restriction to specific types of art.

SOC3.3 Layout Quality

Buildings' floor plans have a significant influence on their functionality and flexibility for different uses. These aspects make a decisive contribution to the quality of a building's design and the space it provides, and to its long term value, as well as influencing user well-being.

**TECHNICAL QUALITY**

TEC1.1 Fire Safety

Fire safety is evaluated on the basis of a checklist. Its structure and how it should be used are described here. The following items will be evaluated if they exceed minimum building regulation requirements:

- avoiding construction materials/products which, in the event of a fire, could create poisonous gases, excessive smoke, or accelerate the spread of fire (e.g. by dripping)
- specifying materials with an increased fire-resistance rating
- providing enlarged cross-sections for smoke extraction
- creating smaller fire/smoke sections
- providing an automatic fire-extinguishing system (e.g. a sprinkler system)
- providing automatic fire/smoke alarm detectors or other alarm systems

A maximum of 10 points is possible. For a positive evaluation of these indicators, the design documents must clearly demonstrate that minimum standards have been exceeded. Note that the building inspection authority allows for alternative fire-safety concepts and permits deviations from the valid building regulation under certain conditions.

### TEC1.2 Sound Insulation

A minimum level of acoustic quality is essential in ensuring that a building can be used for its intended purpose. A room's acoustic quality is a key determinant for the comfort and satisfaction of its users.

The minimum building regulation requirements for structural sound insulation are set down in DIN 4109. Failure to meet these regulations is not permissible for new builds or modernisations with structural encroachment. However, these requirements do not rule out all possible annoyances but just the unreasonable ones. Sound insulation in office buildings must be designed to safeguard people's ability to concentrate, whilst not placing people with restricted hearing at a disadvantage. In hotel buildings the focus lies on creating adequate conditions for the peace and quiet and privacy of the hotel guests. In residential buildings, values higher than those indicated in DIN 4109 are desirable in order to provide enhanced living comfort. Recommendations for increased sound insulation against sound transmissions from neighbouring areas are indicated in supplementary sheet 2 of DIN 4109, VDI Directive 4100 and in the DEGA recommendation 103. For a high-quality building, sound insulation values beyond these recommendations are desirable. Here the aim is not to increase the sound insulation measures beyond a reasonable framework to a considerable extent.

### TEC1.3 Building Envelope Quality

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| | The objective of this criterion is to reduce space heating demand, achieve a high level of thermal comfort, and to prevent damages to the building fabric. |
| TEC1.4 | Adaptability of Technical System# |
| | Amongst a building's many components, its technical systems are subject to the most rapid change, and yet they exert a major influence over its proper functioning. The adaptability of technical systems thus holds a key to buildings' sustainability.<br><br>Highly adaptable technical systems (e.g. responding to changing framework conditions) can make a decisive contribution to user satisfaction, the building's service life and running costs. The objective for planning and constructing buildings today must thus be to make future changes as easy as possible. |
| TEC1.5 | Cleaning and Maintenance |
| | Cleaning and maintaining a building has a major effect on a building's cost and its environmental impact in use. Well-maintained building components last longer. Easy-to-clean surfaces require less cleaning materials and reduce cleaning costs. Hence, the aim is to keep costs for cleaning and maintenance as low as possible and prolong building components useful life |
| TEC1.6 | Deconstruction and Disassembly |
| | The construction sector is one of the greatest sources of material flows worldwide. The material, energetic, and financial effects to which increasing attention is paid are closely linked with the quantities of waste caused. This is also demonstrated by the fact that almost 50 % of the national advent of waste can be attributed to the construction sector. Sustainable construction faces the challenge of reducing the amount of material flow which occurs and guiding it into a cycle of materials. |
| **PROCESS QUALITY** | |
| PRO1.1 | Comprehensive Project Brief |
| | The objective of the criterion is to improve the planning outcome by means of an early requirements planning and corresponding agreements on objectives. Requirements planning establishes builders and users requirements and sets these down in as agreed objectives. This makes it possible to formulate planning objectives clearly and to monitor their consistent implementation. Such project preparation has a considerable influence on the later quality of the building. |
| PRO1.2 | Integrated Design |
| | Integrated design is the basis for the design and delivery of a sustainable building: the close coordination of all project participants from an early |

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| | stage leads to a significant improvement of the design process and the final outcome. |
| PRO1.3 | Design Concept |
| | There is no standard solution for the construction of sustainable buildings. Each project requires new solutions to address the broadest range of issues. In order to make these interact as well as possible and contribute to an optimum solution, an interdisciplinary planning team should develop an integral design approach at an early stage. The appraisal of different design options is thus an important component of focused planning and makes a significant contribution to improved building quality |
| PRO1.4 | Sustainability Aspects in Tender Phase |
| | Integrated design is the basis for the design and delivery of a sustainable building: the close coordination of all project participants from an early stage leads to a significant improvement of the design process and the final outcome. |
| PRO1.5 | Documentation for Facility Management |
| | The objective is to support future building operation with comprehensive documents on the building. This primarily involves information about building parts which are particularly relevant in daily operation such as e.g. the maintenance of surfaces and technical installations. With increasing complexity and mechanisation of the buildings it also becomes ever more important to provide recommendations with regard to the use of the building. Important information about the building can be prepared and transmitted in a focused way in the form of user or tenant handbooks and guidelines. |
| PRO2.1 | Environmental Impact of Construction |
| | Building sites and building processes pollute the local environment through noise, dust, and dirt. The aim of this criterion is to minimise the impact on the local environment and the residents nearby |
| PRO2.2 | Construction Quality Assurance |
| | The criterion assists in the description and evaluation of the construction work. The objective is to rule out defects as much as possible during the construction phase through good building documentation and quality controls, and to record the quality attained. In addition, later conversion and deconstruction measures should be made easier and optimised in terms of their sustainability. |
| PRO2.3 | Systematic Commissioning |
| | The planned commissioning of a building makes a decisive contribution to long-term and efficiently functioning building services engineering. The |

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| | criterion therefore assesses the implementation of well-planned commissioning. |
| **SITE QUALITY** | |
| SITE1.1 | Local Environment |
| | Buildings are subject to many different environmental influences. As a rule, legal regulations appropriately reflect these environmental influences on a building. In addition to this, this criterion deals with extreme events which can clearly influence the condition and value of a building. |
| SITE1.2 | Public Image and Social Conditions |
| | The perception of a location is determined by its current use. However, at the same time it influences the potential for future uses. An industrially defined perception might enhance a location's attractiveness for commercial uses but detract from its attractiveness for residential uses. The location's reputation makes a significant contribution to the building being accepted by its intended users and visitors. A poor reputation can result in the building being empty and demolished prematurely. For the economic and social quality of a location it is therefore crucial that it does not just satisfy functional requirements but also conveys a positive image. |
| SITE1.3 | Transport Access |
| | Transport links are central to site quality. The criterion therefore evaluates the geographical connection of the building to the individual forms of transport (e. g. the distance to the next stop or motorway access) and the efficiency and quality (e. g. frequency) of the respective means of transport. |
| SITE1.4 | Access to Amenities |
| | A location can only be evaluated together with its environment and the amenities provided in the surrounding area. |

# Criteria Catalog ÖGNB – Service Buildings

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| **LOCATION AND FACILITIES** | |
| A.1.1 | Connection to public transport |
| A.1.2 | Quality of local supply |
| A.1.3 | Quality of social infrastructure |
| A.1.4 | Proximity to recreation areas and recreational facilities |
| A.2.1 | Basic risk of natural hazards |
| A.2.2 | Quality of building land and sealing |
| A.2.3 | Alternating magnetic fields in low frequency range |
| A.3.1 | Interior development |
| A.3.2 | Facilities of building object |
| A.4.1 | Accessibility |
| **ECONOMICAL AND TECHNICAL QUALITIY** | |
| B1.1 | Profitability analyses LCCA (Life Cycle Cost Analysis) |
| B.1.2 | Integral Planning and variation analysis |
| B.1.3 | Basis for building operation |
| B.1.4 | Flexibility and durability |
| B.2.1 | Construction site management and logistics |
| B.2.2 | Waste management |
| B.2.3 | Quality of open space |
| B.3.1 | Airtightness of the building |
| B.3.2 | Thermal bridges of the building / humidity protection |
| B.3.3 | Buildings Automation and comfort |
| B.3.4 | Electrostatic floor covering charge |
| B.3.5 | Burglary protection and safety |
| B.3.6 | Special fire extinguisher systems and fire alarm facilities |
| B.3.7 | Approval building service technology |
| **ENERGY AND SUPPLY** | |
| C.1.1 | Heat consumption HWB |
| C.1.2 | Cooling consumption KB |
| C.1.3 | Primary energy demand |

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| C.2.1 | Energy-efficient lighting |
| C.2.2 | Energy from photovoltaic |
| C.3.1 | Individual consumption-based billing |
| C.3.2 | Rain water use |
| C.3.3 | Water-saving sanitary facilities |
| **HEALTH AND COMFORT** | |
| D.1.1 | Thermal comfort in winter |
| D.1.2 | Thermal comfort in summer |
| D.2.1 | Ventilation |
| D.2.2 | Low emission and low pollutant construction materials in interior fittings |
| D.3.1 | Ambient noise simulation |
| D.3.2 | Room acoustics |
| D.3.3 | Noise protection of partition components between buildings units |
| D.3.4 | Impact sound protection of partition ceilings between building units |
| D.3.5 | Continues noise level inside / facility noise level |
| D.4.1 | Quality of the artificial light |
| D.4.2 | Daylight factor |
| D.4.3 | Sun and glare protection |
| **RESSOURCE EFFICIENCY** | |
| E.1.1 | Avoidance of CFC |
| E.1.2 | Avoidance of PVC |
| E.2.1 | Use of regional products |
| E.2.2 | Use of recycling material |
| E.2.3 | Use of products with environmental certificates |
| E.3.1 | O13 Calculation as leading indicator for eco efficiency of the building |
| E.4.1 | Disposal indicator |

# Criteria Catalog GBEL – GB/T 50378-2014

**LANDSAVING AND OUTDOOR ENVIRONMENT**

4.1.1 The site selection accords with local urban plan and meet the construction control requirements of preserved area, historical sites and cultural relics.

4.1.2 The selected site is free from threat as flood, landslide, and radon-containing soil, and within the safe range of the building site. There is no dangerous sources as hazardous chemicals, flammable explosive hazard and electromagnetic radiation danger.

4.1.3 There is no pollution sources exceeding the discharging standard within the site.

4.1.4 The architectural layout of the site meets the daylight standard and does not decrease the daylight level of the surroundings.

4.2.1. Land use saving

The total score for the saving and intensive land is 19 points. As for the residential buildings, the scoring is carried out according to the residential land per capita and the code in Table 4.2.1-1; as for the public buildings, the scoring is carried out according to the floor area ratio and code

4.2.2 Greening rate and accessibility

Fair-arranged green space in the site is given 9 points totally and is scored according to the following codes:

4.2.3 Underground space development

Fair-developed and utilized underground space, which is scored according to the following codes, totally 6 points.

4.2.4 Light pollution prevention

The building and lighting design shall prevent the light pollution, which is scored according to the following codes and accumulated, totally 4 points:

4.2.5 Site Noise

The ambient noise in the field shall comply with the requirements of the current national standards GB 3096 Environmental Quality Standards for Noise, 4 points.

4.2.6 Site wind environment

Wind environment in the field is conductive to travel and move outdoors and natural ventilation of buildings, which is scored respectively according to the following codes and accumulated, totally 6 points:

4.2.7 Heat island intensity reduction

Measures are taken to reduce the heat island intensity, which is scored according to the following codes respectively and accumulated, totally 4 points:

4.2.8 Public transportation access

Field and public transit facilities are convenient for contact, which is scored according to the following codes and accumulated, totally 9 points

4.2.9 Accessible design

Pedestrian passageway in the field adopts the barrier-free design, 3 points.

4.2.10 Parking area plan

Reasonable arrangement of parking lot, which is scored according to the following codes respectively and accumulated, totally 6 points:

4.2.11 Accessible public service

Convenient public services, which is scored according to the following codes, totally 6 points:

4.2.12 Site ecology conservation

Field design and building layout are carried out in combination with the current landform to protect the original natural water area, wetland and vegetation and ecological compensation measures are taken like topsoil utilization, 3 assessment points.

4.2.13 Green rainwater facilities

Take full advantage of field space to arrange the green rainwater infrastructure and a special planning and design is carried out the field with an area larger than 10mm2, which is scored according to the following codes and accumulated, totally 9 points:

4.2.14 Runoff control

Plan ground surface and roof rainwater runoff and control the excretion volume of the rainwater in the field, totally 6 points. 3 points are given if annual runoff volume capture ratio in the field reaches 55% while 6 points if the annual runoff volume capture ratio reaches 70%

4.2.15 Reasonable greening

Select greening mode rationally and configure greening plant scientifically, which is scored according to the following codes and accumulated, totally 6 points:

**ENERGY SAVING AND ENERGY UTILIZATION**

5.1.1 Building design complies with the mandatory provisions in the existing national standards for building energy saving.

5.1.2 The electric heating installations is not used directly as the heat source of air conditioning or heat source of air humidification system.

5.1.3 Measure energy consumption of chill-heat source, distribution system and lighting system independently.

5.1.4 The lighting power density for each room or spaces does not exceed the specified values in existing national standard “Standard for Lighting Design of Buildings” GB 50034

5.2.1 Overall plan & orientation

The shape, orientation, building spacing and window-wall ratio of the buildings shall be optimized in combination with the natural conditions of the field, totally 6 points.

5.2.2 Openable area of façade

Openable part of exterior window and glass curtain wall may make the buildings well ventilated and scored according to the following codes, totally 6 points:

5.2.3 Thermal performance optimization of building envelope

Thermal performance index of enclosing structure is superior to the current national standards in relation to the energy efficiency design, which is scored according to the following codes, totally 10 points:

5.2.4 Chill heat source units energy efficiency optimization

6 points are obtained if energy efficiency of both cold source unit and heat source unit of the heating and air conditioning system is superior to that stipulated in the current national standard GB 50189 Design Standard for Energy Efficiency of Public Buildings and minimum allowable values of energy efficiency stipulated in the relevant national standards. As for vapor compression cycle cold water unit (heat pump unit) driven by motor, direct-combustion and steam-operated libr absorption cold (warm) water unit, unitary air conditioner, all-blast and roof-top air conditioning units, multi-connected air-condition (heat pump) unit, coal fired boiler, oil fired boiler and gas fired boiler, their energy efficiency indexes are increased or decreased from those stipulated in the current national standard GB 50189 Design Standard for Energy Efficiency of Public Buildings by degrees meeting the requirements

5.2.5 Electricity consumption reduction on circulation pump

The ratio of electricity consumption to transferred heat quantity of hot water circulating pump of central heating system and specific energy consumption of blower fan of ventilation and HVAC system shall be compliant to the provisions of current national standard GB 50189 Design Standard for Energy Efficiency of Public Buildings, and electricity consumption to transferred cooling (heat) quantity ratio of circulating water pump of cold and warm water system is 20% lower than the specified value in the current national standard GB 50736 Design Code for Heating Ventilation and Air Conditioning of Civil Buildings, totally 6 points.

5.2.6 HVAC efficiency

Reasonably select and optimize heating, ventilation and air conditioning system, which is scored according to the reduce amplitude of system energy consumption and the code in Table 5.2.6, totally 10 points.

5.2.7 Transition season measure

Measures are taken to reduce energy consumption of heating, ventilation and air conditioning system in the transitive season, totally 6 points.

5.2.8 Partial load reduction measures

Measures are taken to reduce the heating, ventilation and air conditioning system under partial load and space, which is scored according to the following codes respectively and accumulated, totally 9 points:

5.2.9 Illuminating system energy-saving control

Lighting system at the corridor, stairs room, hallway, lobby, large space and underground parking garage is provided with energy-saving control measures like partition, time setting and induction, totally 5 points.

5.2.10 Illumination power density

If lighting power density reaches target value specified in the current national standard GB 50034 Standard for Lighting Design of Buildings, obtain 8 points. The main functional rooms meet the requirements, obtain 4 points; all the areas meet the requirements, obtain 8 points.

5.2.11 Elevator energy saving

Reasonably adopt elevator and escalator and energy-saving control measures like elevator group control and escalator automatic start/stop, obtain 3 points.

5.2.12 Energy saving electrical equipment

Reasonable adopt energy-saving electrical equipment, which is scored according to the following codes and accumulated, totally 5 points:

5.2.13 Heat recovery

If air exhaust energy recovery system is well designed and operated reliably, obtain 3 points.

5.2.14 Cold storage

If cold and heat storage system is adopted reasonably, obtain 3 points.

5.2.15 Waste heat utilization

If the steam, heating or domestic hot water demand are solved by rational utilization of the residual heat and waste heat, obtain 4 points

5.2.16 Renewable energy utilization

Reasonably utilize renewable energy according to local climate and natural resource, which is scored according to Table 5.2.16, totally 10 points.

**WATER SAVING AND WATER RESOURCE UTILIZATION**

6.1.1 Make utilization plan for water resource. Utilize and plan all water resources as a whole.

6.1.2 Design water supply and drainage system reasonably, optimally and safely.

6.1.3 Use water-saving appliances.

6.2.1 Water consumption limits

Taking effective measures to avoid pipe network leakage, which is scored according to the following rules respectively, totally 7 points:

6.2.2 Pipe network leakage avoidance

6.2.3 Overall pressure discharge free

Whether water supply system has overpressure outflowing phenomenon is scored totally for 8 points. Water supply pressure of the water consuming point is no greater than 0.30 MPa, 3 points; being no greater than 0.20 MPa even no less than the minimum operating pressure required by the water appliance, 8 points.

6.2.4 Water metering

Setting up measuring equipment for water consumption, which is scored according to the following rules respectively, totally 6 points:

6.2.5 Public water saving measures

Taking water saving measures to public bathroom, which is scored according to the following rules respectively, totally 4 points:

6.2.6 High water use efficiency sanitary device6.2.7

Application of sanitary apparatus with relatively high water efficiency grade is scored totally for 10 points. The water efficiency grade reaching Grade 3, 5 points; the water efficiency grade reaching Grade 2, 10 points.

6.2.7 Water saving irrigation system

Adoption of water-saving irrigation method for greening irrigation, which is scored according to the following rules respectively, totally 10 points:

6.2.8 Water saving cooling technology for Air conditioning

Adoption of water-saving cooling technology for air-conditioning equipment or system, which is scored according to the following rules respectively, totally 10 points:

6.2.9 Other water saving technologies

Adoption of water-saving technology or measure for other water consumption except sanitary apparatus, greening irrigation and cooling tower is scored totally for 5 points. The ratio of adoption of water-saving technology or measures for other water consumption reaching 50% or 80%, 3 points or 5 points respectively.

6.2.10 Non-traditional water source use

Intelligent use of non-traditional water sources, which is scored according to the following rules, totally 15 points:

6.2.11 Cooling water supplement

Application of non-traditional water sources for cooling water supplement, which is scored in accordance with its ratio accounting for the total water consumption and according to the rules specified in Table 6.2.11, totally 8 points.

6.2.12 Landscape watering system

Design of landscape waters in conjunction with rainwater utilization facilities (rain water supplement for landscape waters being greater than 60% of their evaporation and adopting ecological water treatment technology to safeguard water body quality), which is scored according to the following rules respectively, totally 7 points:

**MATERIAL SAVING AND MATERIAL RESOURCE UTILIZATION**

7.1.1 Construction materials and products prohibited and restricted by local and national government must not be used.

7.1.2 Use hot rolled ribbed steel bar no less than 400 Mpa as bearing force reinforcement bars for beams and columns of concrete structure

7.1.3 The outline of the building is concise with no excessive decorating member.

7.2.1 Architectural and structural form regularity

Preferential adoption of building configuration, which is scored according to regularity of building configuration specified in national standard GB 50011-2010 Code for Seismic Design of Buildings, totally 9 points; irregularity of building configuration, 3 points; regularity of building configuration, 9 points.

7.2.2 Optimized structure design

Making optimal design of foundation, structural system and structural elements to save materials is scored totally for 5 points.

7.2.3 Integrated civil engineering and decoration work

Integration design of civil engineering and decoration engineering, which is scored and according to the following rules, totally 10 points:

7.2.4 Transformable indoor spaces percentage

Adoption of reusable partition wall for indoor space with convertible function in public buildings, which is scored according to the ratio of reusable partition walls and in accordance with the rules specified 5 points.

7.2.5 Prefabricated elements use percentage

Adoption of industrially produced prefabricated parts, which is scored according to consumption of prefabricated parts and in accordance with the rules specified 5 points.

7.2.6 Integrated kitchen and toilet design

Adoption of integration design type kitchen and bathroom, which is scored according to the following rules respectively, totally 6 scores:

7.2.7 Locally produced material

Adoption of local produced building materials, which is scored according to the ratio of the weight of building materials produced within 500km from construction site to the total weight of building materials and in accordance with the rules specified totally 10 points.

7.2.8 Ready mixed concrete

Adoption of premixed concrete for cast-in-place concrete is scored totally for 10 points.

7.2.9 Ready mixed mortar

Adoption of ready-mixed mortar for building mortar is scored totally for 5 points. The ratio of adopted ready-mixed mortar for building mortar reaching 50% or 100%, 3 points or 5 points respectively.

7.2.10 High strength structure material

Reasonable adoption of high-strength building structure materials, which is scored according to the following rules, totally 10 points:

7.2.11 High-durability material

Reasonable adoption of high-durability building structure materials is scored totally for 5 points. For concrete structure, consumption of high-durability concrete accounting for 50% of the total concrete amount, 5 points; for steel structure, adoption of atmospheric corrosion resisting structural steel or atmospheric corrosion resisting anticorrosive paint, 5 points.

7.2.12 Reusable and recyclable material

Adoption of reusable materials and recyclable materials, which is scored according to the following rules, totally 10 points:

7.2.13 Waste material utilization

Utilization of building materials produced from wastes, which is scored according to the following rules, totally 5 points:

7.2.14 Durable decoration materials

Reasonable adoption of high-durability and easy-maintainable building decorating and refurbishing materials, which is scored according to the following rules respectively, totally 5 points:

**INDOOR ENVIRONMENTAL QUALITY**

8.1.1 The indoor noise level of regularly occupied rooms reaches the lower limits in the existing national standard "Code for design of sound insulation of civil buildings" GB 50118.

8.1.2 The sound insulation performance of exterior wall, partition, floor, door and window of regularly occupied rooms reaches the lower limits in the existing national standard “Code for design of sound insulation of civil buildings” GB 50118.

8.1.3 The quantity and quality of building lightings conform to the existing national standard “Standard for lighting design of buildings” GB 50034.

8.1.4 For buildings with central heating and air-conditioning systems, design parameters as room temperature, humidity, and fresh air volume accord with the existing national standard “Design code for heating ventilation and air conditioning of civil buildings”

8.1.5 No condensation exists at the inner surface of building envelope with indoor design temperature and humidity.

8.1.6 Thermal insulation performance of roofs, east and west exterior walls meets the requirements in the existing national standard “Thermal design code for civil buildings” GB 50176.

8.1.7 The concentration of indoor air pollutants such as ammonia, formaldehyde, benzene, and TVOC accords with values in the existing national standard “Indoor air quality standard” GB/T 18883.

8.2.1 Interior noise level (Voluntary)

Indoor noise level for major functional rooms is scored totally for 6 points. The noise level reaching the average value of standard lower limit and standard upper limit specified in current national standard GB 50118 Code for Design of Sound Insulation of Civil Buildings, 3 points; the noise level reaching standard upper limit value, 6 points.

8.2.2 Sounds insulation performance (Voluntary)

Sound isolation performance for major functional rooms, which is scored according to the following rules respectively, totally 9 points:

8.2.3 Noise interference reduction

Taking measures to reduce noise interference, which is scored according to the following rules respectively, totally 4 points:

8.2.4 Special acoustic design

Whether special acoustical design for multi-function room, reception hall, large conference room and other important rooms with acoustical requirements in public buildings meets corresponding functional requirements is scored totally for 3 points.

8.2.5 Vision

Major functional rooms of the building being provided with good outdoor visual field is scored totally for 3 points. For residential buildings, straight distance from adjacent buildings exceeding 18m, 3 points; for public buildings, outdoor natural landscape being able to be seen from major functional rooms through external windows without obvious interference, 3 points.

8.2.6 Daylight factor

Whether daylight factor of major functional rooms meets the requirements of current national standard GB 50033 Standard for Daylighting Design of Buildings is scored according to the following rules, totally 8 points:

8.2.7 Indoor daylight improvement

Improvement of indoor daylighting of the building, which is scored according to the following rules respectively, totally 14 points:

8.2.8 Adjustable sunshades

Taking adjustable sun-shading measures to reduce heat from summer solar radiation is scored totally for 12 points. The areas with controllable sun-shading measures accounting for 25% or 50%, 6 points or 12 points respectively.

8.2.9 Heating and air conditioning adjustable terminals

Independent adjustment of terminals for heating or air conditioning system is scored totally for 8 points. The quantity of major functional rooms with independently start/stop heating or air conditioning terminal devices accounting for 70% or 90%, 4 points or 8 points respectively.

8.2.10 Natural ventilation optimization

Optimization of building space, plane layout and structure design and improvement of natural ventilation, which is scored according to the following rules, totally 13 points:

8.2.11 Reasonable Air distribution

Reasonable air distribution, which is scored according to the following rules respectively, totally 7 points:

8.2.12 Indoor air quality monitoring

Setting of indoor air quality monitoring system for regions with relatively high person-density and large variation with time in major functional rooms, which is scored according to the following rules respectively, totally 8 points.

8.2.13 Underground garages exhausted air monitoring

Setting up of carbon monoxide concentration monitoring device linked with exhaust equipment for underground garage is scored totally for 5 points.

**CONSTRUCTION MANAGEMENT**

9.1.1 Establish construction management system and framework for sustainable building project. Claim responsibility at levels

9.1.2 Develop and implement environment protection plan for the whole construction process by project management department.

9.1.3 Make and implement health and safety management plan for constructors by project management department.

9.1.4 Arrange joint conference on key technology of sustainable building design plan before construction.

9.2.1 Dust reduction

Taking dust-reduction measures such as watering, covering, shielding etc. is scored totally for 6 points.

9.2.2 Noise reduction

Taking effective noise reduction measures. Measuring and recording noise at construction site in accordance with those specified in current national standard GB 12523 Emission Standard of Environment Noise for Boundary of Construction Site is scored totally for 6 points.

9.2.3 Waste reduction

Establishing and implementing the plan for reduction and recycling of construction wastes, which is scored according to the following rules respectively, totally 10 points:

9.2.4 Construction energy saving plan

Establishing and implementing the construction energy saving and consumption plan, which is scored according to the following rules respectively, totally 8 points:

9.2.5 Water saving and consumption plan

Establishing and implementing construction water saving and water utilization plan as well as monitoring and recording construction water consumption, which is scored according to the following rules respectively, totally 8 points:

9.2.6 Ready mix concrete loss reduction

Reducing the loss of premixed concrete, totally 6 points. Reducing the loss rate to 1.5%, 3 points; reducing the loss rate to 1.0%, 6 points.

9.2.7 Reinforced iron loss reduction

Taking measures to reduce the loss of steel bars, which is scored according to the following rules, totally 8 points:

9.2.8 Set shaped steel framework

Using tool-type fixed form to increase concrete form cycling times, which is scored according to the ratio of utilization area of tool-type fixed form and total area of formwork and in accordance with the rules specified in Table 9.2.8, totally 10 points.

9.2.9 Design document implementation

Implementing key contents of green buildings in the design document, which is scored according to the following rules respectively, totally 4 points:

9.2.10 Design change documents control

Controlling strictly alteration of the design document to avoid significant alteration to reduce green performance of the buildings is scored totally for 4 points.

9.2.11 Ensuring building durability

Taking relevant measures to ensure durability of the building during construction, which is scored according to the following rules respectively, totally 8 points:

9.2.12 Integration of civil and decoration constructing

Realizing integration of decoration and construction for civil engineering, which is scored according to the following rules respectively, totally 14 points:

9.2.13 Debugging and test of mechanical and electrical system

The construction unit organizes relevant responsible units to make integrated debugging and test running of electromechanical system prior to completion acceptance and the result meets the design requirements, which is scored totally for 8 points.

**OPERATION MANAGEMENT**

10.1.1 Make and implement management system of energy saving, water saving, material saving and greening

10.1.2 Make waste manage system. Plan waste transportation properly. Collect and classified domestic waste. Plan waste container properly.

10.1.3 Contaminants as waste gas and waste water emitted during operation meet the standard.

10.1.4 Energy-saving facilities and water-saving facilities meet design requirements and work properly.

10.1.5 Monitoring system of heating, ventilation, air conditioning and lighting etc. works properly and the operation condition is completely recorded

10.2.1 Certified Property management agencies

The property management organization achieving relevant management system certification, which is scored respectively according to the following rules, totally 10 points:

10.2.2 Operation procedures and emergency response system

Operating specifications and emergency plans for energy saving, water saving, material saving and greening are complete and implemented effectively, which is scored respectively according to the following rules, totally 8 points:

10.2.3 Energy saving operation incentive mechanism

The energy resource management excitation mechanism is implemented to hook the management achievement with energy resource saving and economic benefit promotion, which is scored respectively according to the following rules, totally 6 points:

10.2.4 Green education and publicity mechanism

Green education and publicizing mechanism is established and operating manual for green facility is prepared to construct good green atmosphere, which is scored respectively according to the following rules, totally 6 points:

10.2.5 Inspection and optimization of public facilities and equipment

Public facilities are inspected and debugged regularly and equipment system is optimized according to the operation test data, which is scored respectively according to the following rules, totally 10 points:

10.2.6 Inspection and cleaning of air conditioning and ventilation system

Air conditioning and ventilating systems are inspected and cleaned regularly, which is scored respectively according to the following rules, totally 6 points:

10.2.7 Non trading water source quality monitoring

Records on quality and consumption of non-traditional water source are complete and accurate, which is scored respectively according to the following rules, totally 4 points:

10.2.8 Intelligent system effectiveness

Operation effect of the intellectualized system meets the demand for building operation and management, which is scored respectively according to the following rules, totally 12 points:

10.2.9 Property information management

Property management is realized through information means, and files and records for building work, facility, equipment, component/energy consumption are complete, which are all scored respectively according to the following rules, totally 10 points:

10.2.10 Pollution free diseases and insects control techniques

Nuisance less pest control technologies are adopted, and the application of insecticide, herbicide, fertilizer, pesticide and the other chemicals is standardized to effectively avoid the damage to soil and groundwater environment, which are all scored respectively according to the following rules, totally 6 points:

10.2.11 Trees survival rate

The once survival rate of trees planted and transplanted is greater than 90% and plants grow in good condition, which are both scored respectively according to the following rules, totally 6 points:

10.2.12 Garbage collection statin stink free

Refuse collection point and dustbin room doesn't pollute the environment or emit outdoor, which is scored respectively according to the following rules, totally 6 points:

10.2.13 Categorized garbage collection and processing

Trashes are collected and disposed by classification, which is scored respectively according to the following rules, totally 10 points:

**INNOVATION**

11.2.1 Thermal performance optimization of building envelope

The score will be 2 points if the thermal performance of building enclosure is 20% higher than that specified in relevant current national building energy efficiency design standard or the annual calculated load for heating and air conditioning reduces by 15%.

11.2.2 Efficiency of cold and heat source units

The score will be 1 point if energy efficiency of both cold source unit and heat source unit of the heating and air conditioning system is superior to that stipulated in the current national standard GB 50189 Design Standard for Energy Efficiency of Public Buildings and evaluating values of energy conservation stipulated in relevant current national standards. As for vapor compression cycle cold water (heat pump) unit driven by motor, direct-combustion and steam-operated libr absorption cold (warm) water unit, unitary air conditioner, all-blast and roof-top air conditioning units, multi-connected air-condition (heat pump) unit, coal fired boiler, oil fired boiler and gas fired boiler, their energy efficiency indexes are increased or decreased from those stipulated in the current national standard GB 50189 Design Standard for Energy Efficiency of Public Buildings by degrees meeting the requirements of Table 11.2.2; as for room air conditioner and home gas fired water heater, their energy efficiency grades meet the requirements for Grade 1 stipulated in relevant current national standard.

11.2.3 Distributed energy supply

The score will be 2 points if distributed combined cooling, heating and powering technology is adopted, the annual comprehensive utilization ratio of energy for the system is not less than 70%.

11.2.4 Level 1 water saving devices

The score will be 1 point if water use efficiency of sanitary ware reaches Grade 1 requirements stipulated in relevant current national standards regarding water use efficiency grades of sanitary wares.

11.2.5 Special structure system

The score will be 1 point if energy-efficient and environmentally-friendly building structure is adopted.

11.2.6 Air purification device

The score will be 1 point if effective air handling measures are adopted in main functional rooms.

11.2.7 Decrease of pollutant concentration

The score will be 1 point if concentrations of such pollutants as ammonia, methanol, benzoyl, total volatile organic compound, radon and inhalable particle in air are not higher than 70% of the limit stipulated in the current national standard GB/T 18883 Indoor Air Quality Standard.

11.2.8 Innovative building plan

The score will be 2 points if climate, environment and resource of the region where the building is located, as well as region characteristics and building functions are considered into the building scheme for technical and economic analysis, and energy resource utilization efficiency and building performances are greatly improved.

11.2.9 Utilization of abounded land

The score will be 1 point if waste site is selected reasonably for building or old buildings which can still be used are fully utilized.

11.2.10 BIM Design, Construction & Operating

The score will be 2 points if building information model (BIM) technology is applied; 1 point if applied in any one stage among planning and design, construction building and operating maintenance and 2 points if applied in two or more stages.

11.2.11 Calculation of carbon emission

The score will be 1 point if computing analysis for building carbon emission is performed and measures are taken to reduce the carbon emission strength in unit building area.

11.2.12 Other innovation strategies

The score will be 1 point if computing analysis for building carbon emission is performed and measures are taken to reduce the carbon emission strength in unit building area. ecological environment protection and safety & health guaranteeing are taken; 1 point if any one of the said measures is taken and 2 points if more than two (included) of the said measures are taken.