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MSc Program
Immobilienmanagement & Bewertung

Increasing the World's Green Building Stock
Why and How?

Master Thesis zur Erlangung des akademischen Grades
„Master of Science"

eingereicht bei
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Wien, 15.04.2014

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Preface

As the world's population continues to increase at an ever accelerating rate, the realization that the Earth's resources are limited, becomes more and more apparent. With an estimated 7.1 billion people on the planet, and another 2 billion to come in the next 30 years[1], the importance of increasing efficiency with regard to electricity, water, land and other essential resources has never been higher. Still, the problem is clearly not be taken seriously enough by the general public. Pretty much wherever you look in the world, most people that can afford to do it, drive their cars alone to work every day without a second thought (in the U.S. for example, over 75% of commuters get to work by driving alone each day)[2]. In China there are currently more than 2,300 coal power plants, which collectively produce hundreds of thousands of tons of sulfur dioxide and nitrous oxide each year[3]. People's in-the-moment personal comfort levels and economic growth are still at the top of the priority list. We want to do things that are good for the environment, but only if they don't affect our day-to-day lives, and don't slow down the economy.

Environmental disasters seem to get our attention, as long as they are bad enough, ongoing, and currently being reported by the media. For example, in recent years there was the Deepwater Horizon oil spill (2010), which spilled approx. 780,000 m^3 of crude oil over a period of 87 days into the Gulf of Mexico, and the Fukushima nuclear disaster (2011), which caused the evacuation of tens of thousands of civilians, and dumped still unknown amounts of radioactive material into the Pacific Ocean. I can recall friends and colleagues talking about these tragedies; swearing that they would never again buy BP gasoline after hearing about how the company had saved on safety costs, or wondering if

[1] http://www.census.gov/population/international/data/idb/worldpopgraph.php, 10.11.2013

[2] National Household Travel Survey, US Department of Transportation, Bureau of Transportation Statistics, 1.1.2014

[3] http://world.time.com/2013/12/13/one-map-shows-you-why-pollution-in-china-is-so-awful/, 01.02.2014

they should be buying iodine capsules, as the radioactive fallout clouds from Japan might drift as far as Europe. Soon after that the stories vanished from the newspapers and life went back to normal. The connection between the energy we use each day, and the demand for the very oil and nuclear materials released into the biosphere seemed to elude most people. That, or they just don't care enough to change anything yet.

Having lived with a relatively strong environmental conscious for as long as I can remember, and planning a career in real estate development, it seemed only fitting to combine the two passions and write about green buildings and sustainability. My goal is to produce a thesis that can be read and understood without the need for an in-depth knowledgebase of either topic; yet provides insight into how sustainable real estate can become tomorrow's standard as quickly as possible.

1 Introduction

In the U.S. 38% of total CO2 emissions come directly from the operation of buildings (not including their construction and demolition)[4]; even more than the 31% produced by the entire transportation industry each year[5], and this in a country with the 3rd highest cars per capita in the world[6]. Additionally, 13.6% of the water and 71% of electricity usage flow into U.S. buildings; while 136 million tons of landfill come from the demolition and renovation of real estate projects each year. Still, in 2014 many people don't even know what a green building or sustainable real estate means. Those that have heard the terms before often think that they refer solely to decreasing the amount of energy a building requires during its useful life (heating, electricity, air conditioning, etc.), and associate saving energy with a reduction in living quality; thereby inferring that green buildings are less pleasant to live or work in. If such a large part of the world's energy resources go into building, sustaining, and operating real estate, then why does the concept remain so foreign to the general population?

This thesis will attempt to demonstrate the importance of minimizing the negative impact of the real estate sector on the environment and on the users of buildings, as well as identify the most important factors relevant to increasing the market penetration of sustainable real estate through an examination of the evolution of several green building rating systems, and a number of other issues relating to human health and well-being.

The first section will discuss the importance of sustainability in the real estate industry, and provide an overview of relevant terms and theories. The evolution of some of the

[4] Kubba, (2012): Handbook of Green Building Design and Construction – LEED, BREEAM and Green Globes. Butterworth Heinemann, Waltham – P. 15

[5] EPA Website on 19.01.2014: http://www.epa.gov/climatechange/ghgemissions/gases/co2.html

[6] http://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita - 21.01.2014

most well-known and commonly-used green building rating/certification systems will also be examined.

The second section will address the question of how to most effectively increase the awareness of and demand for sustainable real estate projects. To investigate this topic a number of sources will be drawn on. An emphasis will be placed on recently published works, which provide up-to-date facts and statistics, as the green real estate game is constantly evolving and (thankfully) growing.

Unless written with capital letters (ie. “Green Building”), the term green building will be used throughout this document to describe sustainable real estate in general.

The post-construction adaptation or renovation of existing buildings in order to increase energy efficiency is without question an area of major potential with regard to sustainability, and several green building rating systems already include protocols for their assessment. This thesis will however, focus on the construction of new real estate projects, and the demand there for.

2 What does Green Real Estate mean in 2014?

This introductory section will examine some of the important terms and concepts necessary to understand what sustainability in the real estate industry currently means.

2.1 Sustainability, Efficiency, and other Terms

Buildings have a large influence on the world around us, both through their construction, as well as their operation, maintenance, and demolition. It is therefore no wonder that in a period in which mankind is becoming more and more aware of its impact on the environment, governments and other policy-making entities are exploring ways in which the ecological footprints of real estate projects can be kept to a minimum. Slowly but surely terms like "Green Building", "passive house", and "sustainable real estate" are creeping their way into our everyday vocabularies. But where did these words come from and what do they really mean?

Sustainable real estate can be described as an umbrella-term, covering many different concepts related to environmentally-friendly, user-friendly, and multifunctional or reusable buildings. While there are different opinions in the architecture and construction communities regarding which approaches result in the most sustainable projects, the general definition of sustainability is more or less consistent throughout the literature. One of the most well-known explanations of the term was provided in 1987 by the United Nations – *"sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*[7]

[7] Sustainable Environmental Design in Archticture – Impacts on Health, Rassia, Pardalos; Springer 2012, P.3

While the core idea remains, over the past couple of decades the concept of sustainable real estate has evolved and become more than just another way of saying environmentally-friendly. Most importantly, modern sustainable projects must also provide better living or working conditions through optimization of air quality, natural light, and other aspects that improve the usability of the building and quality of life for its occupants. Using materials that require less energy and resources to produce, as well as being easier to dispose of (or better yet reuse!), has also become an important part of most, if not all the major green building rating systems.

The U.S. EPA – Environmental Protection Agency defines green building as "*the practice of maximizing the efficiency with which buildings and their sites use resources—energy, water, and materials—while minimizing building impacts on human health and the environment, throughout the complete building life cycle—from siting, design, and construction to operation, renovation, and reuse*."[8]

Below, some of the key aspects of what make green buildings green will be presented.

2.1.1 Carbon Footprint

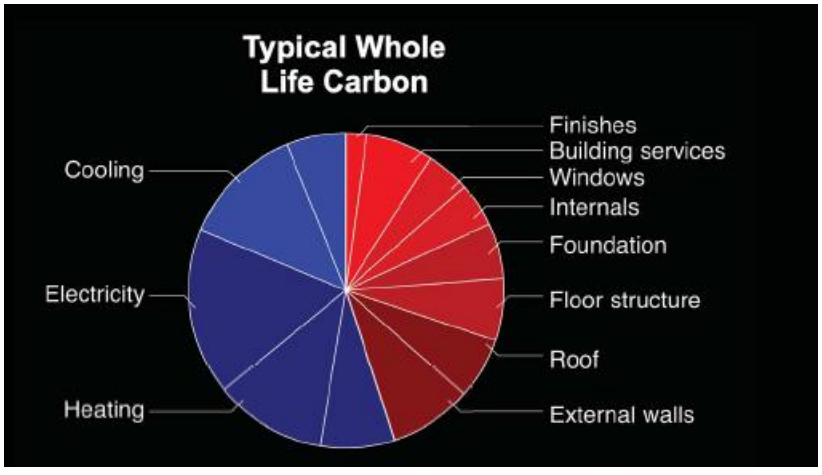
Trying to "reduce our carbon footprint" has become a common phrase when talking about how to commute to work or deciding which method of travel one should choose when going on a trip. Many airlines for example, offer the option of purchasing carbon credits equivalent to the passenger's share of CO2 on a flight in order to make it "carbon-neutral", thereby reducing the footprint of the passenger.

The concept is that each person contributes to the total production of CO2 through their consumption of food, consumer goods, travel, and usage of energy through lighting,

[8] EPA's Green Building Strategy, accessible at http://www.epa.gov/greenbuilding/pubs/about.htm, 04.02.2014

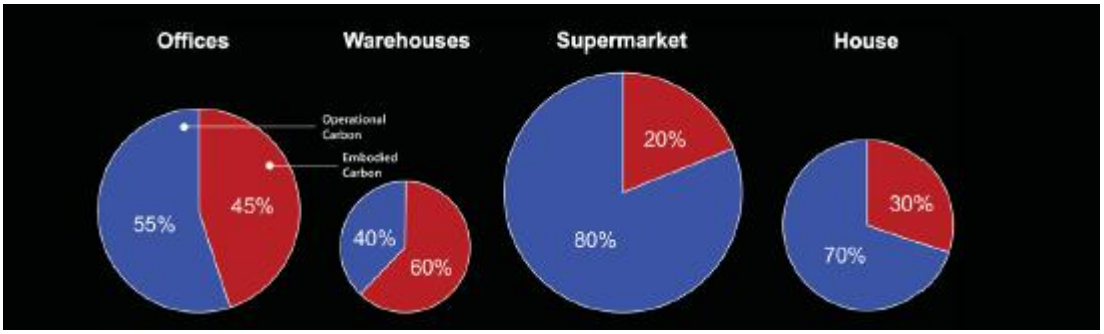
heating, and other daily activities. The sum of the CO2 released through the production of these goods and services during a person's entire lifetime make up his or her carbon footprint. This can naturally also be applied to real estate; whereas a building's carbon footprint is the sum of all the CO2 released due to the production of its building materials, during the initial construction process (as well as any renovations post-completion), the energy consumed during its useful life for operations, and the energy required to demolish the building at the end of its lifecycle. Some researchers even believe that additionally, in the case of workplaces, the CO2 produced by the employees commuting to the building should be included in the equation. This additional factor is up for debate, however the amount of energy used for operations and that needed for the production of the building materials and construction of the project are in any case relevant and can be significantly reduced by implementing green building strategies. One of which deals with including a facility manager in the planning process; which can lead to the recognition of potential inefficiencies much earlier, at a point where they can be avoided by making minor (and therefore relatively inexpensive) changes to the project.

Figure 1.1.1a – carbon footprint of a typical office building, showing the impact of various elements on the total CO2 produced.[9]



[9] RICS Research – May 2010, P. 11

Figure 1.1.1b – carbon footprints of various real estate object types, showing the relative impact of operational and embodied carbon. Note that this does not illustrate the difference in total carbon produced between the various types of buildings. [10]



Another basic principle of building green is to think and plan for the long-term. Modern newly constructed office buildings are built to last anywhere between 40 and 80 years, depending on the type of construction used and the intended use of the structure. The typical real estate developer however, will likely be planning on selling the project soon after completion in order to maximize his return on investment. A typical rental contract for an office runs from 5 to 10 years, after which the tenant has the option to renew or move out. After this initial rental period the owner of the building (at this point most likely not the original developer) will either need to convince the tenant to stay – by offering incentives like a rent-free period or upgrading or refurbishing part of the rental unit, or renovate the unit to comply with the needs of the next tenant. Such measures can be costly, and increase the size of the building's carbon footprint. By taking into account that office buildings (as well as retail and other types of commercial projects) are not just built to satisfy the needs of the initial tenant, but most likely those of a number of future unknown users, more flexibility can be integrated into newly constructed buildings – like planning load-bearing walls and immovable technical areas to be less

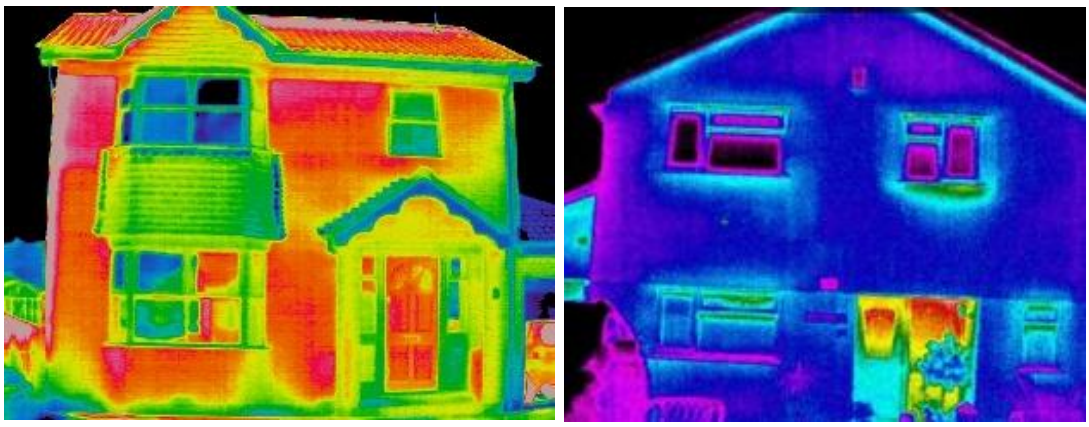
[10] RICS Research – May 2010, P. 11

restrictive, should a future tenant wish to reorganize the layout of the rental unit or combine adjacent rooms.

2.1.2 Operating Energy Efficiency

The classic term associated with, and sometimes confused as a synonym for sustainability is energy efficiency. Keeping energy usage to a minimum is certainly one of the priorities when designing a green building. As previously stated, the operation of buildings consumes a massive portion of the total energy needed to power our civilization. Some of the more common ways to reduce energy usage in buildings are improved insulation and windows to reduce thermal exchange with the exterior environment (see figure 1.1.1), fluorescent or LED lighting in place of incandescent light bulbs, installation of low-energy appliances, integration of solar panels, solar heating and/or geothermal heating, hot water heat recovery systems, passive cooling, green roofs, and designing buildings to make optimal use of natural light.

Figure 1.1.1 – thermographic images showing the difference in heat energy efficiency between buildings. The left image clearly shows a poorly-insulated house, as the varying colors indicate large amounts of heat from inside the building being lost to the external environment (red and yellow being hotter than green and blue). The right image shows a well-insulated structure with only minimal amounts of heat loss, primarily through and around the windows. [11]



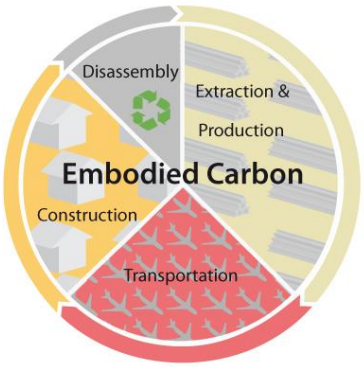
[11] http://cambridgecarbonfootprint.org/action/volunteer-with-us/volunteer-training/house/, 02.02.2014

Studies show that by beginning early in the planning stages of a project, significant gains in energy efficiency and savings in operating expenses can be attained with a minimal increase in initial cost. As an example of what can be achieved by implementing these types of measures, the stringent "passive house" standard in Germany results in buildings that require at least 90% less energy for heating than conventional structures. This relates to savings of 13.5 liters of heating oil per m² per year.[12]

2.1.3 Embodied Carbon

While the meaning and importance of energy efficiency have certainly found their way into common knowledge, the concept of "embodied" (or contained) carbon is not yet a well-known term outside of the green real estate circle. Embodied carbon refers to the amount of CO2 released through the production of all the materials necessary to construct a building, as well as through the construction process itself.

Figure 1.1.3a – illustration of the various components of embodied carbon



Perhaps this part of the carbon footprint equation isn't yet as well-known as energy efficiency because it's not something most people deal with or have the ability to influence on a daily basis. Looking at the facts however, perhaps it's something that

[12] Bauer, Hausladen, Hegger, Hegner, Lützkendorf, Radermacher, Sedlbauer, Sobek, (2011): Nachhaltiges Bauen – Zukunftsfähige Konzepte für Planer und Entscheider. Beuth Verlag, Berlin, P.6

should be granted more consideration. After all, the construction materials that go into a building, when combined with the emissions produced during its erection can be responsible for a substantial percentage of the total production of greenhouse gases resulting, in the case of "front-end heavy" buildings such as warehouses, in the production of up to 80% of the total CO2 produced during its lifecycle. Office buildings on the other hand, tend to be more operationally-intensive regarding energy usage, producing up to 80% of CO2 emissions during their operating-phase – through heating, lighting, air-conditioning, etc. – and 20% during their construction phase (embodied)…nonetheless a significant portion of the total carbon footprint[13].

Another consideration is that as operational energy is reduced, the relative share of embodied carbon to the total carbon footprint of the building increases. Some researchers believe that we will see a massive reduction in the ratio of operational to embodied carbon in the coming years, due to legislation that will target the energy used during daily operations[14], thereby increasing the use of energy-efficient appliances, ventilation systems, and other energy-saving mechanisms. An extreme example is the so-called zero-energy building standard, which produces enough energy through methods like solar panels and geothermal heating, to offset its own energy needs; resulting in net operational carbon of 0. In this case, the ratio of operational to embodied carbon would be 0:1; meaning that the only available mechanism remaining to reduce the carbon footprint is by optimizing the embodied carbon (excluding the option of further increasing the energy produced by the building, which results in a "plus energy house", several of which have already been built in Germany[15]).

[13] Presentation „The concept of embodied carbon" – RICS Event on 07.05.2013 in Vienna, Austria - Mr. Michael Smithing FRICS, LEED AP ID+C, BREEAM International assessor; Director | Green Building Certification Eastern Europe, Colliers International, Chairman of RICS Hungary

[14] RICS Research, P.13

[15] http://www.dw.de/berlin-family-tests-plus-energy-home/a-15933870, 03.02.2014

The amount of embodied carbon can be significantly reduced by choosing a more environmentally-conscious mix of materials and a more efficient construction process. Materials which require long, energy intensive processing like steel, aluminum, some forms of plastic, and even concrete can represent a substantial share of the total embodied carbon of a building. One of the more dramatic comparisons to illustrate this CO2 savings-potential is that of wood vs. concrete. The production of 1 ton of structural concrete produces on average about 410kg CO2.[16] By substituting concrete with materials like wood, which have substantially lower embodied carbon, the carbon footprint of a real estate project can be significantly improved.

Figure 1.1.3b – Illustration of the potential to reduce embodied carbon through the replacement of concrete with wood as a building material. [17]

One principle which will generally have a positive impact on the carbon footprint of any real estate project is to use local materials. This concept is well-known with respect to

[16] Mahasenan, Natesan; Steve Smith, Kenneth Humphreys, Y. Kaya (2003). "The Cement Industry and Global Climate Change: Current and Potential Future Cement Industry CO2 Emissions". Greenhouse Gas Control Technologies – 6th International Conference. Oxford: Pergamon. pp. 995–1000

[17] Reid, H. et al (2004) Using Wood Products To Mitigate Climate Change: A Review of Evidence and Key Issues For Sustainable Development, International Institute for Environment and Development.

fruits and vegetables – the carbon footprint of a kiwi from New Zealand for sale in a supermarket in New York has is significantly larger than that of a locally grown apple. This can also be applied to real estate projects. For example, although imported Italian marble might look great in a luxury bathroom in California, it is certainly not a sustainable solution. Ideally construction materials should be transported minimal distances from their place of extraction, to the factory for preparation, and later to their final installation location. Although difficult to accurately estimate, all of the CO2 produced in each of these phases flows into the carbon footprint of a building. A further benefit of using local raw materials is that the local cultures and traditions of the indigenous communities can be sustained. This aspect of "cultural sustainability" is another concept which should not be overlooked.

2.1.4 Sick Building Syndrome / Building Related Illness

According to the UK's National Health Services "*Sick building syndrome (SBS) is a poorly understood phenomenon where people have a range of symptoms related to a certain building, most often a workplace, and there is no specific identifiable cause*."[18] According to the US Environmental Protection Agency symptoms can include: headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odors.[19]

Due to the importance of employee productivity and the rising awareness of illnesses such as "burnout syndrome", it is difficult to understand why relatively little statistical information about the prevalence of SBS and BRI exists, and why their prevention is not treated with greater importance in all modern workplaces. Although these terms are

[18] http://www.nhs.uk/conditions/sick-building-syndrome/Pages/Introduction.aspx, 02.02.2014

[19] "Indoor Air Facts No. 4 – Sick Building Syndrome", US EPA, http://www.epa.gov/iaq/pdfs/sick_building_factsheet.pdf

beginning to become more well-known by the general public, more research and data is clearly needed, both regarding causes of and solutions to this serious health problem.

2.1.5 Other Green Terms and Concepts

Cradle-to-Grave: refers to the entire lifecycle of a product from the harvesting of raw materials, to its production, up to and including its disposal (grave).

Cradle-to-Gate: refers to the initial portion of a product's lifecycle – from the harvesting of raw materials until its production and readiness to be used (ie. ready to be picked up and the factory's gate)

Cradle-to-Cradle: a relatively new and not yet widely known concept, described in a book of the same title published in 2002 by Michael Braungart and Michael McDonough. The book claims that the idea of cradle-to-grave, and pretty much the whole way in which we evaluate civilization's impact on the planet is flawed. Braungart and McDonough write that humans need not be a negative influence on the Earth; as the current aim of environmental movements is to reduce the influences human society has on the planet; thereby inferring that the natural environment would be better off without us. They suggest rather, that like other parts of the eco-system, we can also be a positive influence and benefit the environment through our presence. Cradle-to-cradle means seeing each product as a part of a never-ending cycle. There is no beginning or end (ie. no grave), and therefore no waste, rather all raw materials necessary for the production of a product served a purpose prior to the products creation and will continue to serve one once the products useful life has ended – just as in nature the biological waste from animals fertilizes the very plants that they consume, ie. waste=food. Braungart and McDonough suggest that by designing products (including buildings) and processes in this way, humans can exist in harmony with their environment. This revolutionary way of thinking could be seen as an even more evolved state of sustainability, through which the Earth could actually benefit from a growing human population.

Biomimicry – this term literally means to copy (mimic) natural biological forms and processes. One well-known case of biomimicry was the study of the lotus flower (known for its ability to repel dirt and water) to produce non-stick materials like paints and fabrics. The concept of biomimicry has also been applied to architecture, by designing buildings based on naturally-occurring phenomena, such as an ant colony or tree. The basic principle is, that nature has spent millions of years perfecting its structures and methods, so imitating them is often more efficient than trying to "re-invent the wheel". Probably the most well-known example of biomimicry in architecture is the Eastgate building in Zimbabwe, which was modeled after termite mounds, and because of its efficient design requires approximately 90% less energy for heating and cooling than other buildings in the area.

Figure 1.1.5 – the Eastgate Centre in Harare, Zimbabwe side-by-side with the type of termite mounds that inspired its design

Some authors believe that the concept can be taken even farther than just copying the way things in nature are built; rather that by imitating the way that nature recycles natural resources like water and nutrients, properties can be developed such that they have no negative impact, or even a positive impact, on the environment.[20]

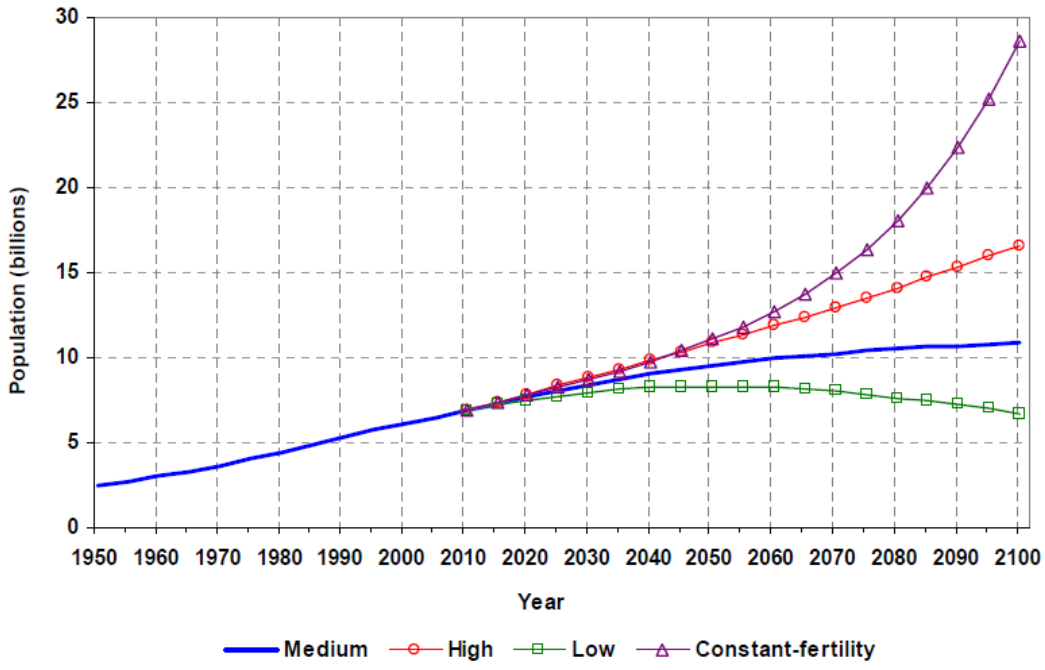
[20] Braungart, McDonough, (2002): Cradle to Cradle. Vintage Books, London, P. 138

LCCA (Life Cycle Cost Assessment) – in a life cycle cost assessment all costs associated with a building's construction, usage, and demolition are calculated. This approach has recently been called into question as a tool for assessing green buildings, as the theoretical future costs are too dependent on factors that cannot be controlled, such as the behavior of building occupants.[21]

2.2 Where we are Now

At its current accelerating rate of increase, the Earth's population could reach 10 billion soon. In 1950 there were just over 2 billion people, and today over 7 billion (see figure 1.3 below).

Figure 1.2 – Graph showing world population growth since 1950 and projected population growth up to 2100.[22]



[21] World Green Building Council, (2013): The Business Case for Green Building, P.29

[22] "World Population to 2300", UN 2004

If the current accepted standard of the OECD (Organization for Economic Cooperation and Development – a forum where 30 industrialized countries address the economic, social, and environmental challenges of globalisation) were applied to the needs of a world population of 10 billion, the emissions produced and resources consumed by the real estate industry alone would be too much for the Earth to handle. Therefore it can be said that "*sustainability on this planet is unthinkable without sustainability in the real estate sector.*"[23]

Furthermore, due to the modern trend of urbanization, the population of the world's cities is set to double by 2050[24]. This projection suggests that in the upcoming decades there will be a massive increase in the demand for office and residential buildings around the world.

The current poverty gap between industrialized and developing nations like China, where a significant percentage of the world's population is found, is another issue for consideration. As the economies of these countries continue to grow at rates much faster than those of any industrialized nations, the expectations for a better quality of life will no doubt also increase (and justifiably so). In order to ensure that the planet remains inhabitable for the next generations, it is imperative that sustainability be taken into account when constructing the vast number of new development projects which can be expected in the developing world over the coming years.

According to the World Green Building Council (WGBC), as of 2013 there were buildings certified under the varying green building rating systems worldwide, representing approximately 1.1 billion square meters of area.[25] This represents about 4% of the total building stock at present. The WGBC hopes to increase this percentage to

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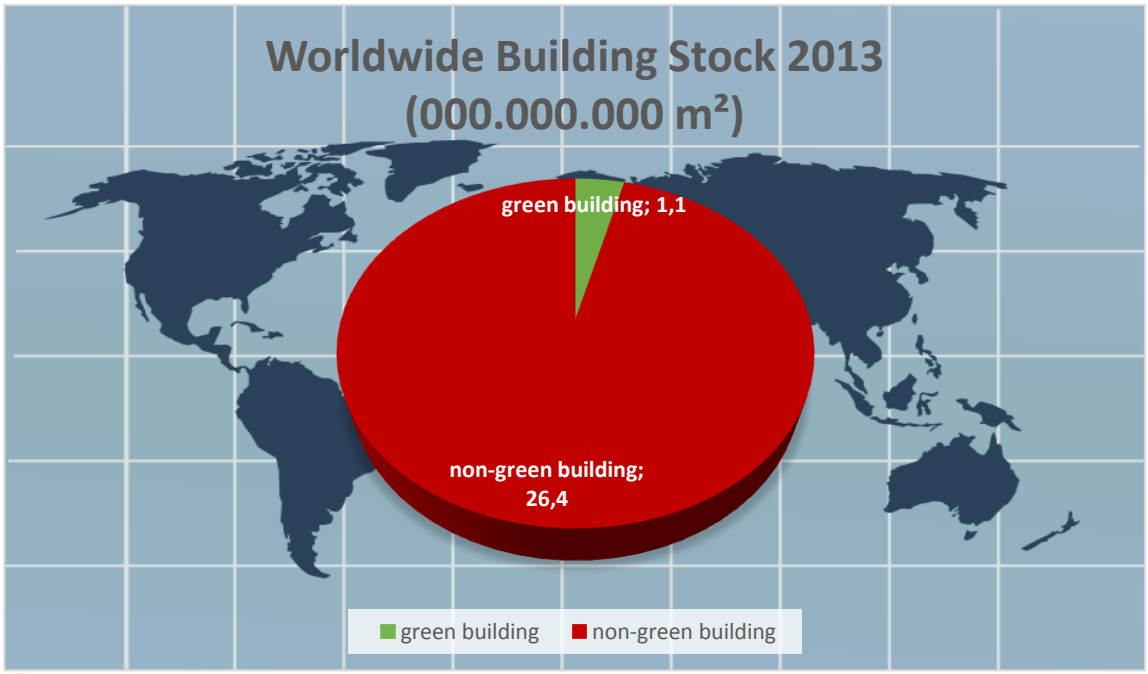
[23] Bauer et al (2011), P.25 – original text "Eine Nachhaltigkeit auf diesem Globus ist undenkbar ohne Nachhaltigkeit im Immobiliensektor"

[24] World Green Building Council, (2013): The Business Case for Green Building, P.4

[25] World Green Building Council Annual Report 2012/2013, P.3

40% within 10 years.[26] In order to make this challenging goal attainable, the required technology, widespread understanding of the concept and necessity of sustainability, and tools and processes for its implementation must be improved and made available as soon as possible.



27

[26] Video, "WorldGBC 2013", http://www.youtube.com/watch?v=exwH5_Jmof8, 05.02.2014

[27] Data from WGBC as stated above, graph self-made

3 Green Building Rating Systems

The next chapter will introduce the concept of rating systems for green buildings, and analyse how some of these have developed over time.

3.1 An Introduction into Rating Systems for Sustainable Real Estate Projects

Together with the need for sustainable buildings comes the requirement to be able to assess the level of achievement reached by each development project. To this end, a number of green building rating or certification systems have been introduced over the last 25 years. One purpose of these systems is to be able to objectively assess the environmental impact of a building, and in some cases as will be discussed, also to rate its usability and social aspects. Furthermore, these systems can be seen as goal setting tools for the real estate industry; creating targets for developers to aim for, and to be used as planning resources for those who have already decided that they wish to build green. In some areas of the world, certification is becoming a mandate for certain parts of the industry.

In order to develop, maintain, and implement these certification systems green building councils have been founded in 93 countries to date.[28] A number of these organizations have created their own systems, while some have chosen to utilize existing ones, or adapt them to their respective regional situations.

Based on the results of a 2010 survey about green building rating systems conducted by the International Facility Management Association, currently the most common reasons

[28] World Green Building Council 2012 Annual Report

for seeking certification for a building are to demonstrate corporate responsibility to the stakeholders and public, and to demonstrate building efficiency.[29] As will be discussed, it is the hope of this author, that the existence of these motivations is merely one step in the right direction, which is for green buildings to be the new industry standard as soon as possible.

Major hurdles at present are represented by the cost of certification, which can range from $50,000 to $300,000 for typical commercial projects, and proof of perceived value from the point of view of the decision makers. Additionally, although countless studies and statistics have been published to disprove this theory, many real estate professionals believe that building green means accepting a significant increase in building costs, that can only possibly be recovered over decades of savings in operating costs.

Green building costs (the actual costs of implementation) continue to fall as supply chains evolve, and government regulations become stricter; thereby raising the general building standards. Cost premiums for green buildings over regular buildings can range from 0 – 12.5%, but typically fall closer to 0 – 4% if projects at the highest levels of certification are excluded (ie. LEED Platinum, BREEAM Outstanding, etc.). One proven method to minimize the additional costs of building sustainably is to avoid treating building green as a "bolt-on" approach, but rather as an integrated process; including green building techniques, and if possible, involving professionals with experience in the field, right from the beginning.[30]

Aside from the declining costs of green building technology in recent years, it should also be considered, that the financial benefit of the associated reduced energy requirements will likely continue to increase in value over the entire lifetime of the building. With the price of crude oil regularly reaching new all-time highs, and

[29] Portalatin, Koepke, Roskoski, Shouse (2010): Green Building Rating Systems, P.6

[30] World Green Building Council, (2013): The Business Case for Green Building, P. 21-22

electricity prices following suit, having an energy-efficient place of business will sooner or later become a necessity for every company.

In order to form a basis for the extrapolation of the future evolution of the green building movement, in the following sections two of the most widely-used rating systems (BREEAM and LEED), as well as two of the newest (DGNB and Minergie) will be examined. Particular attention will be paid to elements of the systems which assess the factors affecting usability and human health, as these points will be addressed in chapters 3 and 4.

3.2 BREEAM - Building Research Establishment Environmental Assessment Methodology

3.2.1 History and Summary of the BREEAM System

As a response to the increasing awareness of modern society's impact on the environment, BREEAM was launched in 1990 by the Building Research Establishment, LLC in the U.K. BREEAM claims to be the most widely-implemented rating system, with over 250,000 projects in more than 50 countries certified, and another 1,000,000 registered for certification as of 2013.[31]

At its launch in 1990 the rating process was descirbed in a relatively short document, consisting of only 20 pages and was designed solely for the assessment of office projects. Over the years, there have been a number of revisions to the documentation, which is now comprised of over 400 pages for the new construction assessment method alone.[32]

The BREEAM system rates buildings based on the following 9 categories:

- Management
- Health & Well-Being
- Energy
- Transport
- Water
- Materials
- Waste
- Pollution

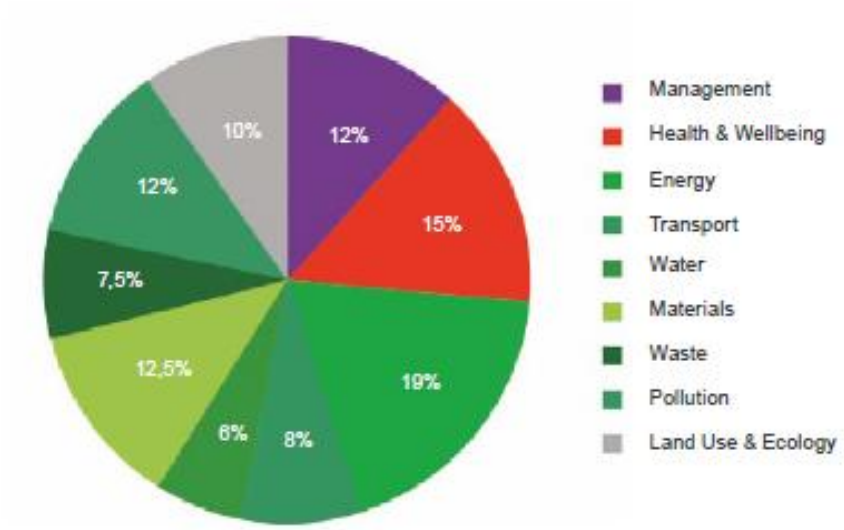
[31] http://www.breeam.org/page.jsp?id=559, 06.02.2014

[32] „The Value of BREEAM", Parker, James, 2012, P. 1

- Land Use & Ecology

The weighting of these categories is displayed in the graph below:

Figure 2.2a – graph displaying the relative weightings of the varying categories in the BREEAM rating system[33]



Following the assessment and weighting of the results, the project is assigned a score and a star rating as follows:

Figure 2.2b – illustration of the varying assessment ratings of the British BREEAM rating system

Assessment score	Assessment rating	Star rating
< 10	Unclassified	–
10 – 25	Acceptable	★
25 – 40	Pass	★★
40 – 55	Good	★★★
55 – 70	Very good	★★★★
70 – 85	Excellent	★★★★★
> 85	Oustanding	★★★★★★

[33] Malestrom, (2009): Green Building – Guidebook for Sustainable Architecture, P.17

3.2.2 Assessment Category “Health & Wellbeing”

In the category “Health & Wellbeing”, which represents 15% of the total assessment score, points are assigned for attempts to improve the internal environment of the building through:

- Heating
- Light
- Air Quality
- Noise

and providing

- Occupant control
- Occupant satisfaction
- Private space.[34]

[34] http://www.breeam.org/page_1col.jsp?id=51, 07.02.2014

3.3 LEED – Leadership in Energy and Environmental Design

3.3.1 History and Summary of the LEED System

The US Green Building Council (USGBC) was founded in 1993 by Rick Fedrizzi, David Gottfried and Mike Italiano. Their certification system Leadership in Energy and Environmental Design was developed in the years following, and launched in 1998, with 51 projects certified in its first 2 years of operation. The system was based substantially on the already existing BREEAM rating tool.[35] According to the 2012 LEED annual report there were approximately 103,000 LEED certified projects worldwide at its date of publishing in 2013[36].

The USGBC's mission statement is "*to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life*"[37].

LEED evaluates buildings based on their performance in the following 9 categories:

- Effects of the building on the ecology
- Water and energy usage
- Sustainable use and transportation of materials
- Indoor air quality
- Location of the building
- Utilization of technology
- Innovation

[35] Kubba, (2012), P.92

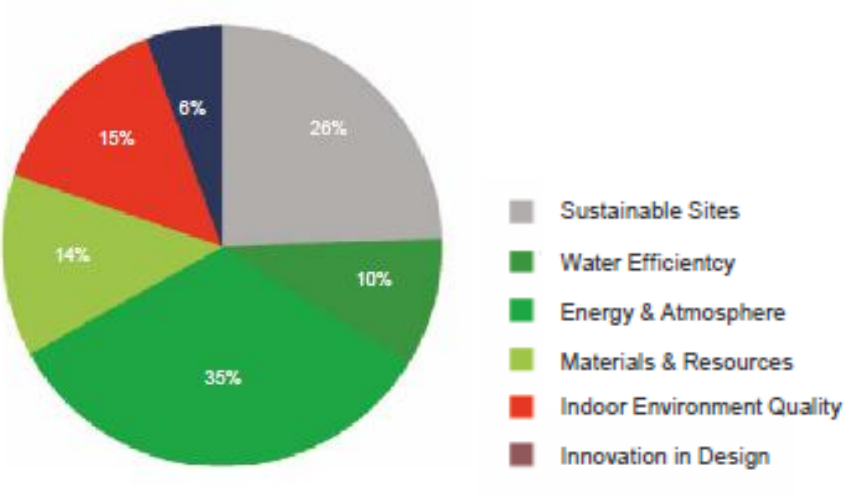
[36] LEED 2012 Annual Report, P. 4-19

[37] "Foundations of LEED", 2009, accessed at http://www.usgbc.org/Docs/Archive/General/Docs6103.pdf

- Regional issues
- Awareness & Eductaion

Following the completion of construction and handover, data regarding water and energy usage is collected during a period from 3 months up to 2 years[38].

Figure 2.3a – Graph showing the weighting of the various categories in the LEED rating system.[39]



Once the assessment process is successfully completed, the project is assigned a rating ranging from LEED certified to LEED platinum.

Figure 2.3b. – the 4 possible certifications awarded by the U.S. Green Building Council's Rating System LEED

[38] Portalatin, Koepke, Roskoski, Shouse (2010): Green Building Rating Systems, P. 14

[39] Malestrom, (2009): Green Building – Guidebook for Sustainable Architecture, P.17

One of the main differences between BREEAM and LEED is the method of certification. During a BREEAM assessment a trained auditor is sent to evaluate the development and report their findings to the BRE, which in turn issues the certification. While involving a LEED-certified "accredited professional" during the development process can be helpful with regard to efficiency and cost reduction, it is not required by the USGBC; as the information can be submitted directly from the applicant using the LEED online system.

3.3.2 "Indoor Environmental Quality"

The LEED system awards up to 15 of the 100 possible points on the basis of indoor air quality, lighting, thermal comfort, and daylight / views. These topics are described below in further detail:

Indoor air quality – the quality of the air for the construction workers during the development process is taken into account, as is the purging of the finished building before handing over to the user. Furthermore, the ability of the ventilation system to change air at a predetermined minimum rate, and to detect the presence of harmful substances such as carbon monoxide is assessed. The building should also be designed with consideration paid to the placement of chemical storage rooms such as maintenance closets; and when necessary, integrate self-closing doors for the event of chemical release. Finally, the avoidance of toxin-emitting substances such as adhesives, sealants, paints, coatings, carpet systems, composite wood, and agrifiber products (such as particle board), or alternatively, their substitution through low-emitting products is rated.

Lighting and Thermal Comfort – the lighting and heating/cooling systems should be highly controllable at an individual level or at least group-level, so as to provide a high level of comfort and well-being. The level of comfort of the occupants will also be verified by way of a survey taken 6 – 18 months after occupancy.

Daylight & Views – the goal is to establish a connection between the indoor areas and outdoors. Generally a minimum specified amount of daylight for 75% of the commonly-used areas is to be achieved. Additionally 90% of occupants should have a direct view of the outside environment from their workspace.[40]

[40] "LEED for New Construction & Major Renovations" Version 2.2, 2005

3.4 Minergie

3.4.1 History and Summary of Minergie

Minergie was introduced in 1998 as an independent label, which is however supported by the Swiss government. The brand aims to "*strengthen important basic principles involved in building for the future*" and employs the slogan "*higher quality of life, lower energy consumption*". So far approximately 33.000 projects have been Minergie certified.[41] The varying levels of certification are as follows:

- Minergie – basic certification, building must have energy (heating) requirements at least 10% below the legal limit, additional construction costs may not exceed 10% of the originally planned costs

- Minergie-P – low-energy building, energy requirements must be at least 40% below the legal limit, additional building costs cannot exceed 15% of the originally planned costs

- Minergie-A – building must require 0 net energy or produce a surplus; additionally all energy needed to power the building must be generated through renewable power sources, which include solar. The maximum amount of "grey energy" (embodied energy) may not exceed 50 kWh/m²a

Figure 2.4.1a – the 3 Minergie certification levels[42]

[41] http://www.minergie.ch/basics.html, 07.02.2014

[42] http://www.minergie.ch/standard_minergie.html, 13.02.2014

In 2005 the following additional, more stringent certifications were introduced by Minergie in cooperation with the organisation “eco-bau”. These certifications require that all prerequisites of the basic Minergie system be fulfilled, as well as a number of additional points regarding user comfort (sufficient daylight, sound insulation, etc.). These “eco-oriented” certifications are appropriately named as follows:

- Minergie-ECO
- Minergie-P-ECO
- Minergie-A-ECO

Figure 2.4.1b – the more stringent and ecologically oriented Minergie-Eco labels

MINERGIE-ECO® MINERGIE-P-ECO® MINERGIE-A-ECO®

The Minergie rating system focuses on the following 7 criteria:

- Health
- Daylight
- Sound Protection
- Indoor Environment
- Building Ecology
- Grey Energy (Embodied Energy)
- Materials and Building Process – including Building Concept

Under the Minergie rating system there are two stages: the pre-assessment and construction stages. In the pre-assessment stage the building plans are submitted and analysed. If the requirements for the certification applied for are met, a provisional certificate is issued. During the construction of the building a more in-depth assessment is undertaken, including spot checks / site visits. If all requirements are met, the final “definitive” certificate is presented following the completion of the project.

3.4.2 Health Aspects of Minergie in more Detail

Of all of the rating systems examined in this thesis, Minergie appears to be the one most engaged with the topic of user comfort and health. On the Minergie homepage there is a substantial amount of information regarding the importance of sufficient daylight and indoor air quality, as well as the effects of harmful substances commonly found in building materials. The specific criteria addressed in the certification process under the category health are as follows:

- Prevention of decreased indoor air quality through VOCs (Volatile Organic Compounds) in the initial weeks of usage

- Low formaldehyde exposure through use of wood as a construction material

- Assurance of good lighting conditions through optimal utilization of natural daylight

- Good acoustic insulation with respect to outside and indoor environments

3.5 DGNB – German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen)

3.5.1 History and Summary of the DGNB System

The rating system DGNB was introduced in 2008, and is therefore one of the most recently introduced green building rating systems. Originally established as a joint project between the German Sustainable Building Council and the German Ministry for Traffic, Building, and Urban Development, the first project was assessed in preparation for the World Conference for Sustainable Building in Melbourne in September 2008; at which DGNB won the World Sustainable Building Award 2008. DGNB's goal is to "*create living environments that are environmentally compatible, resource-friendly and economical and that safeguard the health, comfort and performance of their users.*"[43]

DGNB builds on the basic 3-pillar concept of sustainability (economical, ecological, and sociocultural quality) with the introduction of technical and process quality. Interestingly, the sustainability of the building's location is not considered as part of the rating process. The DGNB is differently structured than BREEAM and LEED, in that it does not assign pre-defined values that need to be achieved in each category, rather targets are defined for each project, allowing for much increased flexibility and therefore innovation.

The five main categories of the DGNB system are as follows:

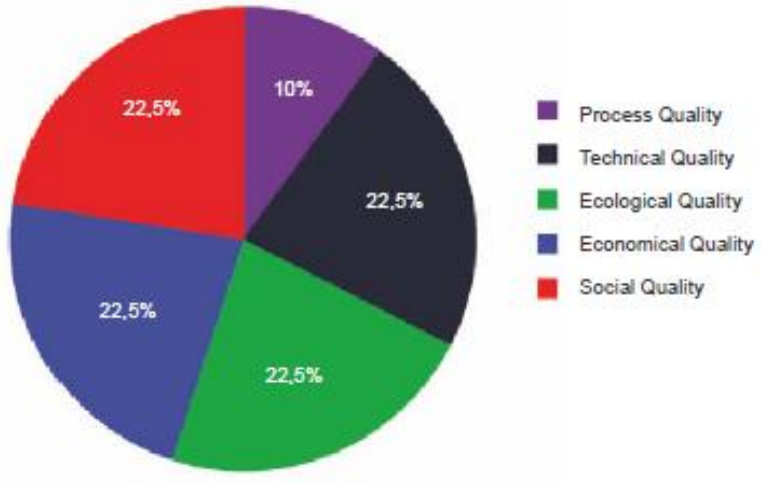
- Process quality
- Technical quality
- Economical quality

[43] Malestrom, (2009): Green Building – Guidebook for Sustainable Architecture, P. 18

- Ecological quality
- Social quality

These five categories are weighted by importance as shown here:

Figure 2.4b – Graph showing the weighting of various categories of the DGNB rating system[44]



Following the assessment process, throughout which a DGNB qualified auditor must be involved, the project is assigned a rating based on the weighted results. The level of attempted certification must be defined by the applicant at the beginning of the assessment process, and ranges from DGNB certified up to gold, as displayed below.

Figure 2.4b – the 4 possible levels of DGNB certification[45]

Gesamter-füllungsgrad	Mindester-füllungsgrad	Auszeichnung	
ab 35 %	— %	Zertifiziert*	DGNB
ab 50 %	35 %	Bronze	DGNB
ab 65 %	50 %	Silber	DGNB
ab 80 %	65 %	Gold	DGNB

[44] Malestrom, (2009): Green Building – Guidebook for Sustainable Architecture

[45] www.dgnb-system.de, 07.02.2014

3.5.2 DGNB Category "Sociocultural and Functional Quality"

The social and cultural aspects are of significant importance to the overall rating awarded by DGNB, representing 22.5% of the total score. The category is further broken down into 3 subcategories and their components as follows:

Health, Comfort, and User-friendliness

- Visual Comfort
- Level of User Control
- Exterior Facilities
- Safety and Accident Risks

Functionality

- Handicap Accessibility
- Area Efficiency
- Conversion Flexibility
- Building Usability
- Bicycle Comfort

Creative Quality

- Architectural Competition
- Art-in-Building [46]

[46] Bauer et all (2011), P. 43

3.6 Other Sustainability Rating Systems of Note

Green Building councils have already been established in over 90 countries worldwide.[47] To date there are 15 different rating systems, whereby the abovementioned systems BREEAM and LEED have certified far more buildings to date than any of the other systems. Several of the remaining noteworthy systems are described briefly below, in no particular order.

Green Globes (Canada) – released in 2002, largely based on BREEAM. Much of the process is web-based which allows for a much more economical assessment, when compared for example with LEED.[48]

ÖGNI (Austria) – ÖGNI, the Austrian Sustainable Building Council was founded in 2009 and assesses buildings based on a 3-pronged approach "products, process, and people". ÖGNI works in close cooperation with the German council DGNB.[49]

CASBEE (Japan) – launched in 2004, this system has been described as using a highly complex weighting system to arrive at a final grade ranging in ascending order as follows: C / B- / B+ / A / S.

Energy Star (US) – launched in 1992 as a joint project between the American Environmental Protection Agency (EPA) and Department of Energy, this internationally employed rating system is concerned solely with energy efficiency, and does not take into account other factors like air quality, use of sustainable materials, etc.

[47] World Green Building Council, (2013): The Business Case for Green Building, P. 15

[48] Kubba, (2012), P.85-87

[49] http://www.ogni.at/de/, 07.02.2014

Green Star (Australia) – developed by the Green Building Council of Australia (GBCA) and launched in 2003. The GBCA currently reports 7.2 million m² of Green Star certified area.[50]

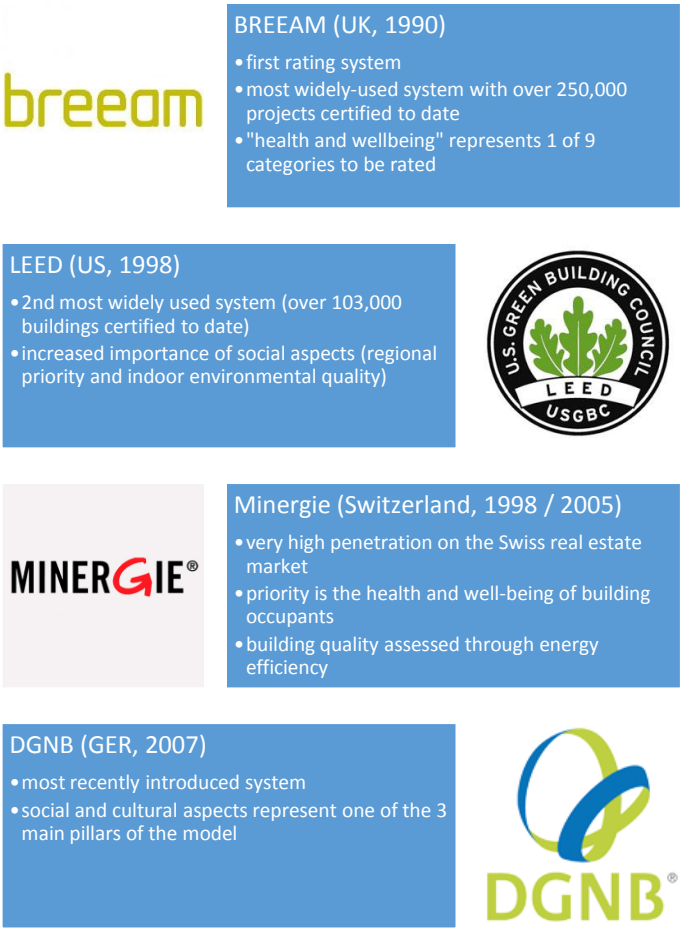
3.7 Summary and a Look into the Future

Having evaluated several of the most widely-used rating systems, it is apparent that a shift toward placing more importance on the value of user health and comfort is already occurring. The more recently introduced systems Minergie (referring more specifically to the Minergie-ECO labels which were introduced in 2005) and DGNB systems both prioritize various aspects of the "human-side" of green buildings during their assessment processes, while the older systems BREEAM and LEED are more concerned with energy efficiency and the usage of greener building materials.

The following flowchart displays the key points of the 4 rating systems discussed, including year of introduction, and relative importance of health and social aspects.

[50] http://www.gbca.org.au/green-star/green-star-overview/, 07.02.2014

Figure 2.5 - Flow chart of the founding of the rating systems, showing relative importance of social aspects.



[51]

Considering the way the rating systems are evolving, what might they look like in 10 or 20 years? Will the public's awareness of the importance of sustainable real estate increase to the point where people will accept nothing less than a green building? Questions such as these will be addressed in the following chapter.

[51] Own resource

A parallel example, which in most countries is already history, would be the shift toward a non-smoking environment in all public places. In Canada for example, like in many other countries, the change took place in several steps. First, having recognized the negative health impact to the general public (and of course, the costs associated with the treatment of smoking-related diseases like lung cancer and emphysema); the government began steadily raising taxes on cigarettes. Smoking was then banned in government buildings and other public buildings like universities. During the early years of the new millennium, regulations regarding smoking in privately-owned restaurants were introduced. This phase, which stretched over several years, consisted of first limiting the square footage of smoking area per restaurant to a certain percentage of the total area of the establishment. Following that, the next step involved restaurants having to install costly glass dividing walls and separate ventilation systems for smoking sections. Soon thereafter, the smoking of cigarettes was completely banned in restaurants and bars; leading to the removal of the glass walls and obsolescence of the ventilation systems. The end result was a smoke-free environment, but the consequences of the staggered approach were unnecessary renovation costs for many restaurant owners and costly fines for those who refused to play by the rules. The same result could have been achieved earlier and with significantly lower costs and less complication if smoking had simply been banned outright in all buildings overnight, as was done in Italy in 2005[52]. Countries that have not yet implemented public smoking bans would do well to learn from the failures and successes of their counterparts when are ready to do so.

Unfortunately the Earth doesn't have a neighboring planet which it can ask for advice on how to most effectively bring in the era of the green building, but by looking at parallel examples from human history, the evolution of the green building movement thus far, as well as other factors to try to predict which elements of the concept of sustainability are the most important and attainable; the necessary information required to form an optimal strategy for its widespread introduction can be predicted.

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[52] "Thank you for not Smoking: evidence from the Italian Smoking Ban" P.2, Buonanno & Ranzani, March 2012, accessed from http://www.carloalberto.org/assets/working-papers/no.246.pdf on 04.02.2014

4 Modern Strategies and Tools for the Increased Market Penetration of Sustainable Real Estate

"We cannot face the challenges of the future with the tools of the past"[53] – Jose Manuel Borosso, European Commission President.

The following chapter will look at some strategies and techniques which are already being successfully implemented, and suggest some of the approaches that will likely gain importance and be seen more in the near future.

4.1 Successful Strategies and Concepts to Date

Although constantly changing and evolving, the concept of green building has been around for several decades. The various techniques of increasing the "greenness" of a real estate project range from simple changes in the layout or position of a building, to complex technological solutions like geothermal heating or smart elevator systems. Next, two relatively simple techniques will be examined; which when correctly implemented, not only provide the opportunity to reduce the environmental footprint of a building, but also offer the added bonus of being able to reconnect humans with the natural cycles of the Earth; a topic which will be discussed in chapter 4.

4.1.1 Green Roofs

The relative surface area covered by roof tops in urban areas can be immense. In some major American cities, roofs account for 20 – 25% of the total land area.[54] The vast

[53] Jose Manuel Borroso, European Commission President at the international conference on Beyond GDP: Measuring Progress, True Wealth, and the Well-Being of Nations, 19-20 November, 2007

majority of roof area is not put to constructive use, rather covered in asphalt, shingles, tiles, or other materials, and outfitted with drainage systems. Conventional roofs are problematic for a number of reasons including the large amount of heat they give off when warmed by the sun, increasing the risk of flooding in the surrounding area due to rainwater runoff; and their need to be repaired and replaced relatively often because of wear and tear caused by sunlight and the elements.

One solution to these problems, which is already being successfully implemented in many countries, is the "green roof".

"*A green roof is a roof surface that supports the growth of vegetation over a substantial portion of its area for the purpose of water and energy conservation. It is comprised of a waterproofing membrane, drainage layer, organic growing medium (soil) and vegetation*".[55]

Green roofs can range from simple grass-covered areas to complex roof-top gardens with large ranges of plant species. Some of the major benefits of green roofs include the reduction in required energy for cooling and heating due to providing better insulation than a conventional roof, increasing the roof's lifespan, as the plants shield the building materials from sunlight and the elements; and significantly reducing the amount of storm water runoff, due to the amount of water retained by the soil and other layers.

A further advantage of green roofs includes helping to decrease the "urban heat island effect", which is becoming a serious problem in many major cities. This phenomenon refers to the constantly increasing temperatures in dense urban areas during the summer months, which ultimately leads to the need for more air conditioning and lower air quality. Studies have shown that the surface temperature of green roofs is typically

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[54] Reducing Urban Heat Islands: Compendium of Strategies, Green Roofs, P. 1

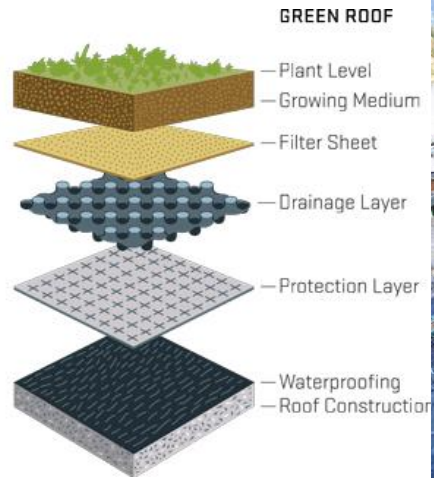
[55] http://www.toronto.ca/livegreen/greenbusiness_greenroofs_eco-roof.htm#a02, 19.02.2014

lower than the outside air temperature on hot days, whereas a conventional roof can be up to 50°C hotter than the ambient air temperature.[56]

Aside from the environmental and financial benefits of green roofs, it should also be taken into consideration that people like to look at and spend time in rooftop gardens. Providing tenants or employees with a green place to relax or take breaks can result in a significant increase in quality of life.

Figure 3.1.1a[57] - illustration showing the layers of a typical green roof

Figure 3.1.1b[58] - Photograph of the roof of the Vancouver Convention Center in Vancouver, Canada



The City of Toronto, Canada established a bylaw in 2009 requiring green roofs on new developments over 2,000m²; making it the first city in North America to adopt such legislation.[59] The widespread introduction of similar laws around the world could be instrumental in reducing the vast amount of energy needed for heating and cooling, significantly decrease the risk of flash floods in some urban areas, and save money and resources which would normally be needed to repair and replace conventional roofs.

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[56] Reducing Urban Heat Islands: Compendium of Strategies, Green Roofs, P. 1

[57] http://designmeans.com, 07.02.2014

[58] ecozome.com, 07.02.2014

[59] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=83520621f3161410VgnVCM10000071d60f89RCRD&vgnextchannel=3a7a036318061410VgnVCM10000071d60f89RCRD#thresholds, 19.02.2014

4.1.2 Rainwater Harvesting and Natural Filtration

An efficient, simple, and relatively inexpensive way to reduce the net water consumption of a building is to employ rainwater harvesting techniques. This entails simply catching the water that naturally falls on to the building's roof and storing it in tanks until it is needed at a later time. This water is generally quite clean, not having absorbed salts and other chemicals which would normally be taken up if the rainwater had run over streets and other surfaces on its way to the nearest sewer. With onsite treatment it can be used as drinking water or untreated, for utilities like toilets. By reducing the amount of water a building needs to consume from the main city network, a great deal of energy is saved, as the collected water does not need to be transported (pumped) to a water treatment plant and back to the site where it is eventually consumed. Additionally, energy and chemicals needed for treatment are saved, as this clean water is never combined with other runoff from roads and farmers' fields. Finally, the harvesting of rainwater can provide an important backup source of water during local shortages or droughts, which will likely become more and more of a problem with the rapidly growing population. Rainwater harvesting systems are currently being implemented in many developing and developed countries around the world. In Bermuda, roof-top collection systems are mandatory for all buildings, and are the primary source for residential consumption.[60]

While collecting rainwater can reduce the need for external clean water delivery, the problem of what to do with the waste water and other substances expelled from buildings into the sewer system also requires a natural green solution. One method is the use of natural water treatment systems. These include fully natural systems such as wetlands or lagoons, which collect, hold, and treat wastewater over a period of three weeks to 3 months using various types of plants and microbes to naturally purify the water before it is filtered and pumped back into the water network; as well as enhanced

[60] Rowe, Mark P., 2011. Rain Water Harvesting in Bermuda. *Journal of the American Water Resources Association* (JAWRA) 47(6):1219–1227

natural systems and biological filters which combine natural and artificial techniques to provide higher quality output water.[61] Natural systems are typically employed for small to medium-sized communities, but can also be implemented locally onsite as a way to reduce the environmental footprint of a building. By reducing the amount of wastewater that flows from a building into the sewer system, the production and use of chemicals needed to separate out the biological wastes is avoided, as this process is achieved naturally.

Rainwater harvesting and natural water filtration are two examples of existing simple techniques to preserve one of the Earth's most valuable resources, and of how green real estate can help reconnect humans to their environment and its natural cycles.

4.2 Up and Coming Trends in Sustainability in the Real Estate Sector and Ideas for the Future

4.2.1 Facility Management and Long-Term Planning

Facility managers (FMs) are responsible for the efficient operation and upkeep of a building or property. Through constant monitoring and reevaluation of the operating and maintenance costs, as well as other running expenses, the financial benefits of engaging a FM can be significant for the owner of the property.

A one-time opportunity to increase the efficiency of a real estate project for its entire useful life is to employ a FM from the very beginning of project and include them in the planning process, rather than waiting until the operating phase begins. By doing so,

[61] „Wastewater Treatment Options for Small Communities", Missouri Department of Natural Resources, 07.2007, P. 1-4

valuable experience and expertise regarding the post-construction phase is made available to the planning team, which can lead to savings in energy and resources.

This opportunity exists due to the fact that real estate developers are often much more concerned with the building costs and initial rents than the long-term rentability and efficiency of a project – information which will be much more relevant to the future owners or users after it is sold at a profit. Additionally, architects typically prioritize designing a "work of art" for which they will be recognized by colleagues and the community, and the construction companies are mostly concerned with coming in under budget for the works they have been hired for. A FM on the other hand is tasked with optimizing the efficiency of a project well beyond its opening date, and will quite possibly continue on after the initial tenants have moved out and been replaced. When one considers that a FM can be the only member of a planning team which is truly motivated to keep the long-term costs (and therefore energy, water, and other resource requirements) down, it becomes clear why including one in the development phase can be so advantageous.

Perhaps the future will lead to developers being required to close long-term FM-contracts before being allowed to submit a construction project for approval by the authorities. By doing so, the interests of future users, and indirectly the environment itself could be represented during the planning phase of each project – the time at which it is by far easiest and most efficient to make adaptations.

4.2.2 Redefining the word "Sustainability" once again

As already mentioned, the term sustainable real estate is often mistaken as another way of saying energy efficiency. Having discussed the concepts of embodied carbon, it should be considered that sustainable buildings need to be successful at whatever they are designed for in order to keep the total combined carbon footprint of the real estate industry small. If an office building needs to be demolished after 20 years because its

high vacancy rate has made it impossible to finance, it was never really a sustainable project, despite all of the high-tech energy-reducing features it may have employed.

With this consideration in mind, perhaps particularly prosperous real estate projects should be given bonus points; as their existence will prevent the need for further projects to be built. For example, retail shops located on Oxford Street in London could be seen as some of the most sustainable shopping establishments in the world, as the number of customers is so high that the need for larger, more complex shopping centers is avoided. Downtown Manhattan could also be seen in this light, as the usage of space per m^2 is so intense. It almost doesn't matter how much power the stores use for air conditioning and lighting, the energy usage per shopper will be lower than larger, more spacious mega shopping centers in other cities. The internal comfort for the workers and quality of air in the city itself however, are another story. The point is that sustainability is not a static concept. As our understanding of the world, technology, and human behavior evolves, so too must the definition of this important word.

Although highly complex, perhaps it would be more accurate to measure the "net greenness" of a building by considering the overall effects on the city or region in which it is built; as illustrated in the abovementioned examples.

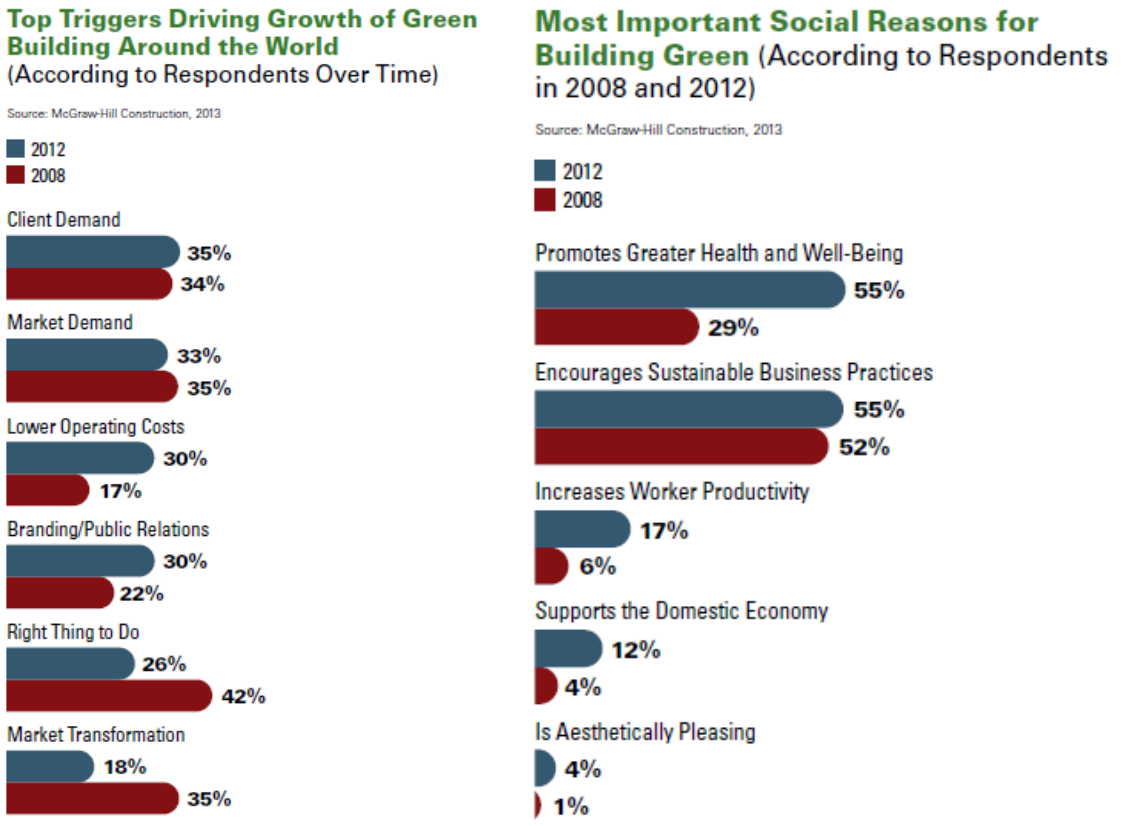
4.2.3 Increase Public Awareness

Perhaps the single most powerful tool to increase the market penetration of sustainable real estate is public education. In 2014 it is certainly common knowledge that the use of cars, airplanes, and other forms of transportation is responsible for the production of huge amounts of greenhouse gases. Whether or not the (much greater) environmental impact of the construction and operation of buildings is also understood by the general population is at best unclear. By increasing public awareness of the potential environmental and financial savings, as well as the possibility to increase the quality of life for occupants, it could be possible to make living or working in a green building

much more desirable at the level of the building user, thereby increasing pressure on developers and governments to prioritize sustainable development.

A 2013 report by McGraw-Hill Construction analyzed responses to a survey from 62 countries about motivating factors leading to the decision to build green. As the charts below illustrate, it would appear that the awareness of the social benefits of green buildings is increasing; as the factors like lower operating costs, increasing worker productivity, and promoting greater health and well-being all influenced the decision to build green significantly more in 2012 than in 20008.

Figure 3.2.3[62] - Results of a 2013 Report by McGraw-Hill Construction showing a comparison of the motivation behind deciding to build green between 2008 and 2012.



[62] McGraw-Hill Construction (2013): World Green Building Trends SmartMarket Report.

This trend should be recognized and supported, perhaps by making an introduction to green buildings part of the standard school curriculum, or investing more in studies that investigate the real added value of building green – due to both the direct and indirect cost savings.

4.2.4 Governmental Participation and Intervention

As previously mentioned, people in today's society are to at least some extent environmentally conscious. As long as their day-to-day routine isn't threatened, the quality is at least as good, and no additional costs result, most people would be willing to switch a regular product for a comparable environmentally-friendly one.

Unfortunately, this lukewarm sentiment is not even close to where our society needs to be, given the Earth's current state. In order to motivate, or even force people and businesses to act more greenly, the governments of the world need to impose incentives for those that take initiative (for example, tax breaks for companies that install solar panels), and penalties for those that don't follow the rules (for example, fines for companies that produce too much CO2). Often these measures are implemented far later than they could have been due to political or other reasons, although the necessity is evident much earlier.

The current financial crisis has people looking to their governments for help creating jobs and speeding up the economy; certainly not the ideal time for these decision makers to bring in strict new regulations which limit the construction of new real estate projects to buildings which satisfy a minimum green standard. Nonetheless, as illustrated, this is a necessity not only for the long-term future, but for the short-term as well, and its needs to be dealt with now.

The amendment to the EU's energy guideline published on 18.06.2010 is an example of one of the policies currently in place, and set the following targets for all EU member states:

a) By 31.12.2020 all newly constructed buildings must fulfill the requirements of a low-energy building; defined as being highly energy efficient and requiring close to no external power, which if necessary, is to be drawn from renewable sources on site or within close proximity, and

b) beginning 01.01.2019 all new government buildings must be low-energy buildings[63]

These goals are commendable, and their achievement would represent an important step toward reducing Europe's future energy usage to a long-term sustainable level. However, once again this can be seen as an example of regulations being brought in as emergency measures. Given the world's current energy problems, it is understandable that the focus of sustainable real estate lie on energy efficiency (this is also much easier to justify politically, as energy efficiency is linked with immediate savings in operating costs), however if these new buildings are to be accepted by the people who use them and fulfill the requirements of the generations to come, they must be designed with the needs and desires of humans in mind.

Perhaps if people understood the long-term ramifications of green building, and that new jobs and economic improvement could result directly from growing this currently world-wide trillion-dollar-industry[64], they would be more willing to accept a few additional rules and regulations for the greater good.

[63] Bauer et al (2011), P.30

[64] PDF The Business Case for Green Buildings, P. 2

On the one hand, it is a shame that in order to reign in the era of the green building, and environmental efficiency in general, the average person (as well as the average company) must either be forced – through taxation or other legislative measures, or offered incentives - by creating subsidies or by drawing attention to the often overlooked secondary benefits like increased employee productivity in green office buildings. On the other hand, this is the world we live in, and that's the way people are; so in order to make progress in this increasingly important field, factors such as these – regardless of how dissatisfying and frustrating they may seem, must be accepted as given.

The next section will look at the important aspects of green buildings from the point of view of the users, and by doing so further emphasize the importance of increasing the world's green building stock as quickly as possible.

5 The Human Factor

The following chapter will discuss some of the additional factors (other than energy efficiency) that make sustainability in the real estate sector so important.

5.1 The Modern Human Condition

Modern city-dwellers, which make up an ever-increasing portion of the world's population, have lost touch with nature. This is a relatively new phenomenon, which has only really existed since the beginning of the industrial revolution. Before the widespread use of electricity and other modern comforts, humans, just like all other forms of life on the planet, were linked to the natural cycles of the planet we live on. Daylight and the darkness of the night were the alarm clocks of earlier human societies; dictating when to wake up, and when to sleep. Unlike today where most workplaces are lit by fluorescent tubes, which often burn well into the evening hours in many offices – some people don't even see the sun during some parts of the year depending on the amount of work they have to do. People have also managed to break free from the restrictions imposed on them by the seasons. Aside from the driving conditions and the need to wear an extra layer on the way from the parking lot to the office, most people's daily routines don't look very different in summer or winter. Which other animals on the planet behave this way? Modern humans have standardized their workday, separating them from the day/night and summer/winter cycles, on the basis of which they have evolved over hundreds of millions of years. The question is, at what cost to their quality of life, and to the environment?

The fact that mankind is burning through its natural resources at an exponentially faster rate than they can be replaced is nothing new. That the greenhouse gas emissions from our cars and industry like carbon dioxide, methane, and nitrous oxide are destroying the ozone layer, which is essential to the continued survival of life on Earth, is beyond

debate and more or less common knowledge in 2014. Sustainability measures to protect the current and future generations have already been adopted by many countries and international organizations. The Kyoto Protocol for example, which set targets for countries around the world to reduce greenhouse gas emissions, was adopted in 1997, and entered into force in 2005 for the European community and 37 other industrialized countries[65]. To date 192 countries are parties to the agreement[66], showing that there is at least some awareness on a global level, of the need to reduce the environmental damage inflicted on the planet each year. Whether or not this particular mechanism, or others like it, have been effective so far, is another topic altogether.

When examining the various factors necessary to unite the countries of the world in common environmental protection goals, the fact that everyone shares the same planet can be seen as an advantage or as a hurdle to overcome. While it is true that the emissions from and damage done by our neighbors also affects our well-being, and vice-versa, thereby motivating each side to "do to others as you would have them do to you", there is also the mentality "if our neighbor doesn't do it, then why should we?" at work, which can be illustrated by the refusal of the U.S. to ratify the Kyoto protocol, and Canada's withdrawal in 2012.

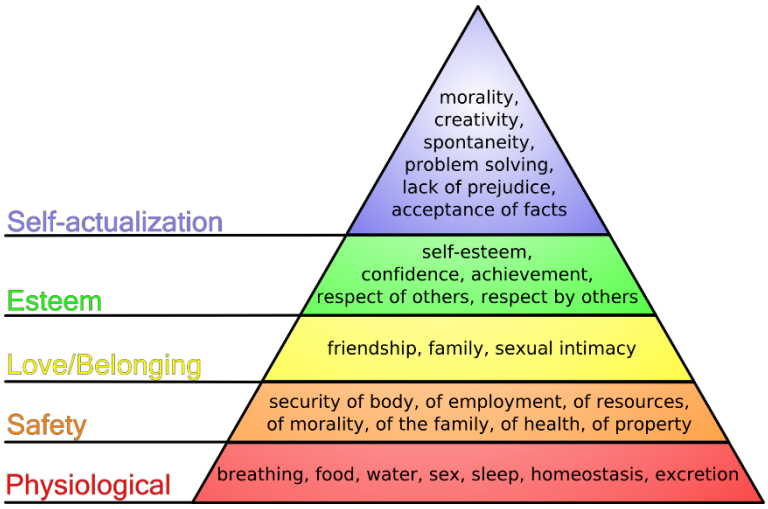
Creating effective environmental protection systems and agreements based solely on goodwill and on a volunteer basis is unfortunately not yet something that our civilization is capable of. In order to see immediate and maintainable results, we need to explore other ways to motivate the world into going green. In order to identify the most effective ways to motivate people to change their behavior, a brief look at Maslow's well-known hierarchy of needs can be helpful. The diagram, which shows the importance of various human needs based on their location in the pyramid (needs at the bottom of the pyramid are the most important, decreasing in importance up to the top), gives some insight into

[65] http://unfccc.int/kyoto_protocol/items/2830.php, 02.02.2014

[66] https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-a&chapter=27&lang=en, 02.02.2014

why Kyoto and other such approaches might not be the best way to achieve effective results. Campaigns and agreements based on the idea of reducing environmental damage because it's "the right thing to do" or because "everybody else is doing it" would be categorized into the very tip of the pyramid under *morality* or *respect of others*, needs that are very high up and thus, do not become priorities until other more basic needs are fulfilled. While the use of Maslow's hierarchy of needs may seem out of place in a research paper about sustainable real estate, it should first be considered that people are the primary users of buildings as residences, workplaces, and many others applications (as will be discussed in the next section, the vast majority of our lives is spent indoors). Appreciating this categorization of needs is also vital to understanding how people make decisions and why.

Figure 4.1.1 – Maslow's Hierarchy of Needs[67] - the diagram illustrates and categorizes the needs or requirements of a human being, beginning with the most fundamental basic needs at the bottom, increasing in complexity up to the peak of the pyramid. Maslow theorized that if the more basic needs are not fulfilled, an individual will focus more strongly on them before attempting to satisfy the more complex secondary needs. (ie. if the physiological needs like food, water, and sleep are not being taken care of, other more complex needs like morality of self-esteem will generally be seen as secondary).



[67] Maslow, A. H. (1943). A Theory of Human Motivation. Psychological Review, 50(4), 370-96, graphic from: http://smallbiztrends.com/2009/04/green-business-maslows-hierarchy.html.

5.2 90% of our Lives Indoors!

Americans and Europeans spend on average approximately 90% of their lives inside.[68] [69] That may seem shockingly high at first, but if the 24 hours of a day are broken down into 8 hours of sleep plus 4-6 hours of leisure time at home, and 8-10 hours at the office on a workday, it starts to become realistic.

The time spent in one's home sleeping, eating, watching television, etc. represents a great deal of a person's life. Choosing a house or apartment that is comfortable and located in a desirable area is pretty much common sense and is generally what people do, assuming they have the required financial resources.

Focussing on the time spent at work, whether it is an office, factory, or other type of facility, these 40-50 hours per week multiplied by 50 weeks per year and a 45-50 year career represent a significant portion of a person's total lifetime. Optimizing the conditions in which these roughly 100,000 hours are spent should certainly be a priority for anyone who wants to improve their quality of life; but is not necessarily as simple as renovating or moving to a new home.

The quality of living in the workplace should also be a priority of all employers, as 85% of the typical workplace costs in an office building are represented by salaries and benefits[70], whereas only 10% is made up by rent and less than 1% by energy. Furthermore, improved indoor environmental conditions can lead to increased productivity in employees.

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[68] Summary of EPA Green Building Strategy, November 2008 (http://www.epa.gov/greenbuilding/pubs/greenbuilding_strategy_nov08.pdf)

[69] Press Release: "Indoor Air Pollution", European Commission - IP/03/1278, 22.09.2003

[70] RICS. (2010). Is Sustainability Reflected in Commercial Property Prices: An Analysis of the Evidence Base. Research Report.

Alternatively, avoiding the downsides to poor indoor environmental quality should be an equally important priority of business owners. Evidence shows that symptoms associated with sick building syndrome can lead to significant reductions in productivity, averaging 3% when 3 symptoms are present, and an 8% loss with 5 symptoms[71].

If the moral concept of wanting to improve the life quality of one's employees, and reduce or stop the damage to the natural environment isn't enough to justify implementing green building strategies, then the financial advantages provided through increased productivity should be considered.

5.3 Indoor Environmental Quality

"Indoor environmental quality (IEQ) refers to the quality of a building's environment in relation to the health and wellbeing of those who occupy space within it."[72]

A 2003 study by the European Commission showed that the concentration of some pollutants in several major European cities was significantly higher indoors than outdoors. The study also provided the disturbing information that several schools examined showed higher levels of some aromatic compounds than were present outdoors; substances that might be particularly dangerous to students with certain health problems like asthma or allergies.[73] Other studies on indoor air have shown that the presence of pollutants can be 2 – 5 times higher than outdoor air[74]. This can be caused by a number of factors including low-quality building materials, lack of maintenance of

[71] Sustainable Environmental Design in Architecture, P. 71

[72] http://www.cdc.gov/niosh/topics/indoorenv/, 07.02.2014

[73] Press Release: "Indoor Air Pollution", European Commission - IP/03/1278, 22.09.2003

[74] Sustainable Environmental Design in Architecture, P. 120

ventilation systems such as the changing of filters, excessively complex ventilation systems which tend to provide more possibilities of something going wrong.[75]

Humans are animals. They like to think that they are far superior to other forms of life on the planet, but at their core, they are all pretty much the same. They need oxygen, water, food, and other physiological basics, like sleep, to survive.

People also like to believe that their buildings protect them from the outside environment; shielding them from the elements and providing a safe and comfortable place to live or work. But how many people have actually verified this theory by having the air quality in their office or residence tested for toxic substances? Fresh air is not only vital to survival, but is essential to being able to concentrate and work on complex tasks. A US study in 2004 reported:

"*it has now been shown beyond reasonable doubt that poor indoor air quality in buildings can decrease productivity in addition to causing visitors to express dissatisfaction. The size of the effect on most aspects of office work performance appears to be as high as 6-9%".*[76]

A Study by Lawrence Berkely National Laboratory found that improving indoor air quality in workplaces could save up to $58 billion worth of sick leave and could earn $200 in additional worker productivity.[77]

Teachers at the first school in Austria to achieve passive house standard believe that one of the reasons for the excellent concentration skills of their students is the quality of the air provided by the passive ventilation system.[78]

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[75] Sustainable Environmental Design in Architecture, P. 215-216

[76] http://www.ncbi.nlm.nih.gov/pubmed/15330777, 07.02.2014

[77] Kubba, (2012), P. 83

[78] Building the Future, P.24

In addition to air quality, a number of other factors relating to indoor environmental quality such as temperature control, amount of natural daylight, and access to outside views can materially affect the performance or productivity of workers and other occupants of a building. The advantages of improving several of these factors are illustrated in the graphic regarding LEED certified projects below.

Figure 4.1 – Graphic illustrating some of the benefits of increasing indoor environmental quality.[79]

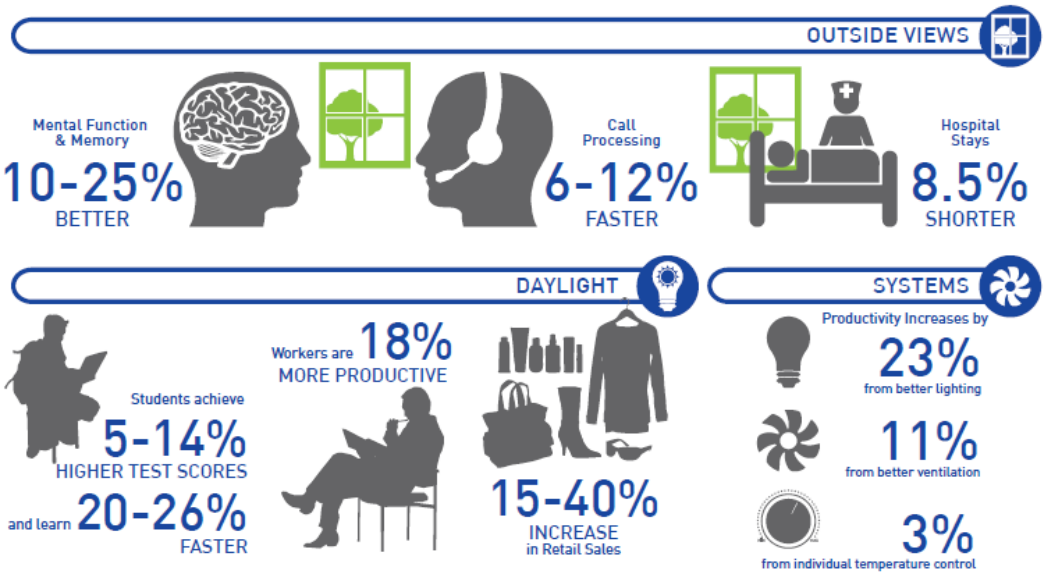

Figure 11
Net present value analysis of the operational cost and productivity and health benefits of LEED certified buildings

One of the most common criticisms of low-energy buildings and passive houses is that a secondary effect of their main energy-saving mechanism, decreasing heat lost through better insulation and making the building essentially as air tight as possible, is a significant decrease in air quality within the building due to the increased level of pollutants from insulation and other sources not being able to escape.[80] It is essential to

[79] World Green Building Council, (2013): The Business Case for Green Building, P. 67

[80] Braungart, McDonough, (2002): Cradle to Cradle. Vintage Books, London, P. 63

the further integration of sustainable real estate, that claims such as these be investigated and either publicly disproven or corrected, should they be justified.

"*Despite evidence of its impact, improved indoor environmental quality has not been a priority in building design and construction, and resistance remains to incorporating it into financial decision-making*."[81]

The further research and distribution of information about the effects of improved environmental indoor quality should be promoted. Helping decision makers to understand the value which lies in this widely untapped opportunity could be beneficial to increasing the market penetration of green real estate projects.

5.4 Back to Basics

One recurring theme that can be found in many recent texts about the topic of sustainable real estate is the idea of keeping it simple. Mud structures and timber frame houses are perfect examples of simplistic designs which make use of the resources of the surrounding area, and allow the people living in them to remain connected with their natural environment.

Also important to the widespread adoption of green buildings is affordability. "*Sustainable architecture that only a fraction of the world population can afford is not future-oriented*."[82]

[81] World Green Building Council, (2013): The Business Case for Green Building, P.9

[82] "Building the Future – Maßstäbe des nachhaltigen Bauens". Hans Drexler & Adeline Seidel (Hg.) 2012 by jovis Verlag GmbH, Berlin P.13 – Original text: "Eine nachhalitge Architektur, die sich nur ein Teil der Weltbewölkerung leisten kann, ist nicht zukunftsfähig"

Researching simplistic and perhaps seemingly antiquated ways of constructing buildings from around the world, and not rushing to implement complex technological solutions could be important to the spread of green real estate in many developing regions.

5.5 Make Anything other than Green Buildings Undesirable

The key is to focus on the humans in the buildings. Make sustainable real estate projects so comfortable to live and work in, that people will refuse to work in anything other than a green building. Knowingly moving into a new apartment with lead piping and asbestos would be unthinkable to anyone in this day in age. Both materials have been known for decades to cause serious health problems in the long-term. Increasing the awareness of the dangers lurking in the average apartment or office, and offering a viable alternative is how the era of the green building should be brought in. Sunlight, fresh air, clean drinking water, and scenic views of the outdoors should be the standard, not the exception. Companies should be rushing to sign up for projects like these; especially considering that "*the cost of securing and supporting a talented and productive workforce is a hundred times as great as the carrying cost of the average building*."[83]

[83] Braungart, McDonough, (2002): Cradle to Cradle. Vintage Books, London, P. 74

6 Conclusions and Outlook

The necessity of increasing the world's green building stock is evident for a number of reasons, including the Earth's current environmental problems, and the poor quality of working and living conditions provided by many non-green buildings at present.

By examining the rating systems used to certify sustainable real estate projects, a trend toward placing more importance on the increase of the quality of life for the users of the buildings can be observed. Considering the importance and benefits of improving indoor environmental quality, placing more focus on the factors that affect the usability and health of the occupants of a building is logical, and could play an important role in ushering in the new era of the green building standard – for example by further increasing the point-values of these subjects in rating systems, and creating subsidies and tax-breaks for companies that take steps in this direction. Monitoring of the upkeep of these standards after the start of operations will also be vital. Jobs can be created to monitor indoor environmental quality more closely, and costs of funding the subsidies can come from the savings in sick days and health-care costs for the treatment of SBS related disorders.

"R*esearch shows that the green design attributes of buildings and indoor environments can improve worker productivity and occupant health and well-being, resulting in bottom line benefits for businesses*."[84]

Sustainability in the real estate industry cannot be implemented as a one-size fits all concept. It may seem complex to tailor solutions to the varying needs of different people, industries, and cultures around the world. But "*if we are to solve the problems*

[84] World Green Building Council, (2013): The Business Case for Green Building, P.9

that Plague us, our thinking must evolve beyond the level we were using when we created those problems in the first place" – Albert Einstein[85]

Developers, architects, and other professionals involved in the planning process have the ability to play a role in shaping the society of tomorrow. As previously stated, modern people spend approximately 90% of their lives indoors, so their quality of life is largely dependent of the quality of the buildings in which they live, work, and play.

Basic sustainability concepts, including what buildings are made of and how to reduce energy at home and work should be a mandatory part of every education. We need to avoid at all costs, becoming one of the grim societies depicted in many films set in the future.

The need for more data about how buildings affect their occupants is mentioned in countless reports about green development. Research projects conducted in controlled laboratories with no daylight or external stimuli often do not offer findings that coincide with our complex reality. The 2012 documentary "What Happiness Is" showcased the country of Bhutan's process of surveying how happy its population is with complex questionnaires and a team that travels from village to village helping the people to complete them. The result is the government's ability to calculate the country's "Gross National Happiness"; as Bhutan is one of the world's poorest nations, and they believe that growth in the average person's happiness is a much better indicator of success than economic data would be. Perhaps a similar approach could be taken with real estate satisfaction. Since people spend the vast majority of their lives indoors, it would certainly make sense to know if people are happy with their residences, workplaces, and other buildings in which they regularly spend time. Employers could for example, be required to submit information annually based on anonymous surveys filled out by all employees. In any case, the lack of data about how buildings and building materials

[85] Braungart, McDonough, (2002): Cradle to Cradle. Vintage Books, London, P.165

affect people needs to be addressed in order for safe, reliable products and processes to be able to be developed for the future.

The accelerated implementation of green buildings around the world could significantly help in preserving what is left of the Earth's natural environment, and would result in improved quality of life for those in and around the buildings. The current infrastructure for certifying sustainable real estate projects is still developing, and seems to be evolving in the direction of occupant well-being. Due to the extreme importance of this industry to the modern civilization, more resources should be invested into research, education, and government intervention; aimed at increasing the world's green building stock as quickly and efficiently as possible.

Abstract

In the U.S. 38% of total CO2 emissions come directly from the operation of buildings (not including their construction and demolition); even more than the 31% produced by the entire transportation industry each year, and this in a country with the 3rd highest cars per capita in the world. Additionally, 13.6% of the water and 71% of electricity usage flow into U.S. buildings; while 136 million tons of landfill come from the demolition and renovation of real estate projects each year. Still, in 2014 many people don't even know what a green building or sustainable real estate means.

Americans and Europeans spend on average 90% of their lives indoors. The quality of people's lives is therefore largely related to the quality and habitability of the buildings in which they spend the vast majority of their time.

This thesis will attempt to demonstrate the importance of minimizing the negative impact of the real estate sector on the environment and improving the quality of life for the users of buildings, as well as identify the most important factors relevant to increasing the market penetration of sustainable real estate through an examination of the evolution of several green building rating systems, and a number of other issues relating to human health and well-being.

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