ENHANCING BUILDING RATING SYSTEMS BASED ON CARBON FOOTPRINTING

By

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To my Mom for inspiring me to undertake this challenge

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TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
BEE	Building Environmental Efficiency
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Building Environment Efficiency
CBECS	Commercial Building Energy Consumption Survey
CMU	Construction Masonry Unit
CSI	Construction Specification Institute
DGNB	Deutsche Gesellschaft fur Nachhaltiges Bauen
DOE	U.S. Department of Energy
DQI	Data Quality Indicators
EDIP	Environmental Development of Industrial Products
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
FER	Fossil Energy Ratio
FFCA	Full Fuel Cycle Assessments
FTE	Full Time Employees
GBCA	Green Building Council of Australia
GBI	Green Building Initiative
GWP	Global Warming Potential
IBEC	Institute for Building Environment and Energy Conservations

IPCC	International Panel on climate Change
ISO	International Organization for Standardization
JaGBC	Japan Green Build Council
JSBC	Japan Sustainable Building Consortium
LCA	Life Cycle Assessment
LCABRS	Life Cycle Assessment for Building Rating Systems model
LCC	Life Cycle Costing
LCIA	Life Cycle Impact Assessment
LCID	Life Cycle Inventory Database
LEED	Leadership in Energy and Environmental Design
MLIT	Ministry of Land, Infrastructure, Transport, and Tourism
NAHB	National Association of Home Builders
NIST	National Institute of Standards and Technology
OSB	Oriented Strand Board
PPD	Physical Property Division
REC	Renewable Energy Credits
REPA	Resource and Environmental Profile Analysis
SETAC	Society for Environmental Toxicology and Chemistry
STARS	Sustainable Tracking Assessment and Rating System
TNS	The Natural Step
TOPP	Tropospheric Ozone Precursor Potential
TRACI	Tools for the Reduction and Assessment of Chemical and Other Environmental Impacts
UNEP	United Nations Environmental Programme
USGBC	U.S. Green Building Council
World GBC	World Green Building Council

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As sustainability becomes more of a focus for the built environment, various rating systems have been developed in order to attempt at quantifying which buildings would be considered more sustainable than others. Despite the popularity and government endorsement of the LEED rating system, it has received wide spread criticism for giving certification to facilities that may not prove to be beneficial to the environment. One of the current indicators of sustainability can be measured through the Life Cycle Assessment (LCA) of the materials and their cumulative carbon footprint. By comparing the LCA's of similar buildings that were designed and constructed with and without the LEED rating system in mind, a great deal of information can be acquired regarding the effectiveness of using the rating system. Additional comparisons can be made to other world wide rating systems in order to develop more comprehensive methods for evaluating the sustainability of facilities.

CHAPTER 1
INTRODUCTION

Henry Gifford in his paper on “A Better Way to Rate Green Buildings”(Gifford 2009) points out many of the problems associated with the current LEED system. One of his chief arguments is that actual energy usage of LEED rated buildings in some cases actually use more energy than their non-LEED counterparts. His recommendation is that buildings should not claim to be sustainable until they have actually demonstrated some form of energy savings instead of simply using predictive models. Essentially, this emphasizes the importance of establishing a criterion for rating buildings that is based on empirical results and recognizes that the single largest contributor to buildings environmental impact is due to energy usage. But taking this one step further, not all energy sources are the same. For example, as Gagnon et.al point out in their paper “Life-cycle assessment of electricity generation options: The status of research in year 2001”(Gagnon, Bélanger & Uchiyama 2002), fossil fuel sources are shown to have poor pay back periods and significant contributions to global warming potential. By using Gagnon et al.’s analysis involving life cycle assessment, one of the optimum measures of performance is carbon emissions. However, when considering carbon emissions, it is important to also look at the life cycle of the building since impacts can be realized through manufacturing, construction, and demolition processes in addition to the routine operations. Thereby, it would be better to consider the building with the least overall carbon emissions to be considered more sustainable.

Statement of the Problem

Despite the popularity and U.S. government endorsement of the LEED rating system, it has received wide spread criticism for giving certification to facilities that may not prove to be beneficial to the environment. One of the currently used indicators of sustainability, carbon footprinting, can be measured through the life cycle assessment (LCA) of a building. By performing a comparative analysis based on carbon footprinting of a LEED certified building versus a non-LEED building, information can be gained regarding the effectiveness of the LEED rating system in categorizing facilities as compared to another approach. Additionally, from analyzing the same buildings through other international rating systems, the gaps in analysis techniques can be discovered, and an effective methodology can be developed to resolve the discrepancies and improve future building rating systems. As a detailed LCA can provide much more information beyond the carbon footprint, it is worthwhile to also examine the other parameters of the data to determine if there are factors that may be more environmentally sensitive or have a greater impact that have not been researched.

Hypothesis

According to a recent study on carbon footprint calculation methods conducted by Pandey et.al in 2010 (Pandey, Agrawal & Pandey 2010), the current methods for calculating the carbon foot-print of a facility can require extensive amounts of data and be very time consuming. In order to simplify the process so that it can be used by laypersons, shortcuts are often incorporated that result in an erroneous carbon footprint. It is hypothesized that a method can be developed in which a correlation can be established between building rating systems and carbon footprinting to determine sustainability of a facility based on the full building life cycle.

Objective and Contribution

This research intends to streamline the process by developing an efficient methodology to facilitate the carbon calculations and includes relevant impacts for the life cycle of the building. Advantages of a more comprehensive application of a metric to the life cycle of a building include the ability to analyze each aspect of the design and operation phase to quickly locate areas with the greatest impact and thereby facilitate the process of finding improvements.

From examining a variety of rating systems, a better understanding can be developed of what they are measuring and how the systems compare with each other. Similarly, gaps in rating systems can be identified that should focus future research into developing remedies. Overall, by improving the rating systems, it can make them more verifiable and reduce some of the differences between actual and predicted results. Additionally, by integrating a more rigorous methodology into building rating systems, it is intended that future generations of facilities will be actually more sustainable.

Limitations

It is the goal of this research to develop a methodology and model that can be used in a specific situation. The model will have the ability to be expanded and altered to comply with a full range of requirements; but that will be incumbent upon future research. This project is intended to develop the framework with the understanding that it is not an all-inclusive system. Due to limitations in data availability relative to the life cycle of various processes, the model has been fit as best as possible with the current technology. As new data is developed, it can be augmented into the program and further enhance the results.

CHAPTER 2
LITERATURE REVIEW

Continuing research attests to the damage that is being done to the planet by humans. According to the Intergovernmental Panel on Climate Change, “Global mean surface temperatures have risen 0.74^{o}C when estimated by a linear trend over the last 100 years… Droughts have become more common, especially in the tropics and subtropics, since the 1970s… Changes in the large-scale atmospheric circulation are apparent” (Trenberth et al. 2007). Campbell & Laherrère (Campbell, Laherrere 1998)report that “the global demand for oil is currently rising at more than 2 percent a year… forecasts that worldwide demand for oil will increase 60 percent by 2020” . And Vitousek et al.’s research (Vitousek et al. 1997)has shown that human alterations are responsible for increasing nitrogen input into the terrestrial nitrogen cycle, increased concentrations of potent greenhouse gases, caused loss of soil nutrients, contributed to the acidification of soils, streams, and lakes, increased the quantity of organic carbon stored within ecosystems, and contributed to long-term decline in coastal marine fisheries.” Amidst all the cries of global warming, oil crisis, loss of potable water, and ecological destruction; a common reply is that we need to live more sustainably. The challenge is further aggravated in that we have a difficult time even being able to define what we mean by sustainable. The common agreement is that sustainability needs to take into account the “Triple Bottom Line”: 1.) Environment, 2.) Society, and 3.) Economy. Most professionals recognize that all three are significant factors in the sustained quality of life. However, there is much debate on how these factors should be measured and weighted against each other. Since they involve varying metrics, it is difficult to establish a consistent tool for measuring the impacts and ensuring an equitable balance.(Kibert 1999).

Although sustainable actions should be a factor in the process of daily life, in order to demonstrate the ability to make significant changes this evaluation will focus on one of the largest industrial sectors. It has been reported by the US Department of Energy (Kelso 2011) that the built environment uses 40% of the U.S. energy and that the U.S. is the world's largest energy consumer. Thus implying that the US construction industry is one of the largest sectors for worldwide energy consumption. In other nations the trend is similar with regards to energy and resource consumption due to building construction, operation, and demolition.

Some people think that by calling something “green” it is synonymous with sustainable and attempt to market their products or services by adding a quick label that tends to lack any true significance. Terra Choice Marketing Inc.(TerraChoice Environmental Marketing 2007) performed a survey of leading big box stores in 2006 to attempt to quantify the level of “greenwashing”. The survey found that of 1,018 products, there were 1,753 claims of the environmental benefits. Of those products, all but one were demonstrated to have some level of being “false, or risk misleading intended audiences”. As would be expected, this further dilutes the issue and does little to truly help the global issues. This also raises the question on who should be considered the competent authority for establishing what is considered sustainable.

Zimmerman & Kibert (Zimmerman, Kibert 2007) point out the importance of aligning rating systems to established sustainability principles. Based on their research on the topic, it has been proposed that perhaps the best definition that can be applied to sustainability comes from a process called “the Natural Step”. By using this definition, it is possible to continue with sustainable growth while still monitoring the impacts on the environment, society, and the economy. Having been sanctioned by several governments in addition to numerous environmental regulatory authorities, this definition may provide the best starting point for understanding sustainability.

The Natural Step

The idea for The Natural Step (TNS) originated from a Swedish doctor and cancer scientist, Dr. Karl-Henrik Robèrt. In the 1980’s, while he was treating children cancer patients, he noticed how the disease had a far reaching impact beyond just the individual suffering from the condition. Entire communities would pull together to provide care and resources to help the individual along with the families work through the challenges of the disease. It struck Dr. Robèrt that this was in direct contrast to how society was dealing with the discussions concerning global warming or other perceptions on the well-being of the planet.

According to “The Natural Step Organization” (Price-Thomas 2011), Dr. Robèrt formulated his idea while examining one of his cancer patient’s cells under a microscope. His theory was to consider what would happen if we were to apply the basic understanding of cells to the Earth. In essence, this would imply treating human beings and our environment as single cell organisms with respect to how they dwell in their surroundings. From this standpoint, we could also depart from a political nature and just focus on what are the cause and symptoms of the problem and then as a knowledgeable community we could work together to find solutions to safeguard the precious entity of life.

Essentially, the Natural Step relies on a principle that the earth is sustainable systems that can self-regulate its environment as long as there is no external interference. A network of international scientists has concluded that, for several centuries, mankind has been altering with the earth's natural regulatory system in ways that are outside of the normal remedial methods. There are essentially three ways that the earth is being impacted directly by human activity. When the social impacts of man are included with the discussion, the framework provides four areas in which we must regulate our activities in order to maintain sustainability. The following table summarizes those actions:

Table 2-1 The Natural Step System Conditions

The Four System Conditions	Reworded as The Four Principles of Sustainability
In a sustainable society, nature is not subject to systematically increasing:	To become a sustainable society we must…
Concentrations of substances extracted from the earth's crust	Eliminate our contribution to the progressive buildup of substances extracted from the Earth's crust (for example, heavy metals and fossil fuels)
Concentrations of substances produced by society	Eliminate our contribution to the progressive buildup of chemicals and compounds produced by society (for example, dioxins, PCBs , and DDT)
Degradation by physical means	Eliminate our contribution to the progressive physical degradation and destruction of nature and natural processes (for example, over harvesting forests and paving over critical wildlife habitat); and
And , in that society, people are not subject to conditions that systemically undermine their capacity to meet their needs	Eliminate our contribution to conditions that undermine people's capacity to meet their basic human needs (for example, unsafe working conditions and not enough pay to live on).

To properly apply The Natural Step, it is critical to understand the principle of "Backcasting". It is not enough to simply look at our current activities; we must also consider all future actions that would result due to our actions. This can be a difficult process to estimate accurately since there can be so many unknown factors affecting the future. For the most part, previous scenarios can be examined for their history and the lessons learned can be applied to potential new situations. This type of analysis is the basic structure of performing a life cycle analysis on an event. Thus through backcasting we are able to obtain a vision of what the impacts will be on the Earth and society enabling us to evaluate if there is any impact on the four Natural Step principles affecting sustainability. As will be discussed later, one of the better methods for conducting backcasting is by performing life cycle analysis.

Despite arguments by various individuals such as Zimmerman &Kibert on the value of including tools such as The Natural Step in the assessment of buildings, there remain a wide variety of rating systems and the aspects they use to determine sustainability are very diverse. It is worthwhile to look at some of the building analysis techniques to determine how they evaluate sustainability and attempt to draw a consensus on a more universal parameter such as carbon dioxide.

Building Assessments

As sustainability has become a more demanded aspect for building construction, various rating systems have been developed in order to quantify how sustainable one building is compared to either a baseline or another building. Recognizing the value of being able to set parameters for construction and likewise encourage more forward thinking regarding energy and material conservation has prompted numerous nations and environmental organizations to develop their own rating systems. Since many of the rating systems are merely country specific adoptions of other successful rating tools, the remaining section will focus more on original techniques that involve parameters related to measuring the carbon emissions or examine aspects of the building life cycle assessment.

Building Research Establishment Environmental Assessment Method

The Building Research Establishment (BRE) (BRE Trust 2011) traces its roots back to 1917 with the foundation of the Building Research Station under the Department of Scientific and Industrial Research. The initial charter of this British organization was to investigate sustainable housing techniques to be used following the First World War. Since that time, BRE has focused on many aspects of building material research to include fire protection, safety, and environmentally consciousness. In 1990, they launched the building rating system BRE Environmental Assessment Method (BREEAM) (BRE Global Ltd. 2008) to measure the sustainable performance of facilities.

The BREEAM certification is based on the results from a licensed third party company in which the accessor has received specialized training in BREEAM rating systems. The categories reviewed for certification include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology, and management processes. The final assessment of the building is awarded a percentage ranking based upon the performance relative to a benchmark established for similar facilities.

BRE claims that BREEAM is flexible enough to be used anywhere in the world for a full range of new and existing buildings. The schemes available for allocating buildings are very broad and include: new construction, refurbishment, and communities. Under the new construction scheme they include numerous specific buildings such as: courts, data centers, education, healthcare, industrial, offices, prisons, retail, and other. To measure the carbon emissions of the building BREEAM uses a formula designed by the BRE Carbon Trust Initiative. The results of the carbon emissions are applied directly to the BREEAM rating system to become part of the overall rating.

Leadership in Energy and Environmental Design

In the United States, the first group to develop a building rating system was the U.S. Green Building Council (USGBC 2011). The USGBC was founded in 1993 as a non-profit coalition committed to expanding sustainable building practices. In November 1999, a national conference met in California to review global activities and share information. This led to the development of the World Green Building Council by 2002, with a goal of formalizing international communications, help industry leaders access emerging markets, and provide an international voice for green building initiatives. The USGBC is a member of the World GBC in addition to 20 other nations. Overall, including prospective members and emerging GBCs, the World GBC impacts over 80 countries (WGBC 2010).

In 1998, the USGBC released a pilot version of their building rating tool: Leadership in Energy and Environmental Design (LEED). By March of 2000, the first public version of LEED was available. The rating system is designed to be regularly updated and the latest revision was performed in 2009. The entire program is web based in which all data and documentation is uploaded and partially reviewed by members of the Green Building Certification Institute.

The LEED rating system (USGBC 2009) acts a quasi-standard in that it uses the standards of many different other organizations; but does not have any standards in itself other than the rating tool. To evaluate the buildings, the LEED program uses a scorecard to identify how many points apply to a particular project. Based on the number of earned points in addition to meeting the requirements of several pre-requisites, the project may be able to qualify for a building certification of either: Certified, Silver, Gold, or Platinum. Although starting as a program primarily for New Construction, the LEED program has developed separate scoring systems for: Residential, Schools, Core and Shell, Commercial Interiors, Retail, Healthcare, Neighborhood Development, and Existing Buildings

The primary LEED scorecard for New Construction is divided into 6 various categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design. Within each of these categories a variety of requirements establish the minimal level of accomplishment in order for the building to earn points in either the design or construction phase. There is currently no program for third party verification of the actual building. Although a pilot program has been started to look at LCA of the materials selected in the design phase, there is no credit provided based on carbon emissions calculations.

Comprehensive Assessment System for Building Environmental Efficiency

In Japan, a joint industrial/government/academic project was initiated in April 2001 with the support of the Housing Bureau and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). This group led to the establishment of a new combined organization under the administrative control of the Institute for Building Environment and Energy Conservation (IBEC): the Japan Green Build Council (JaGBC) / Japan Sustainable Building Consortium (JSBC). The JaGBC/ JSBC were tasked with developing the necessary subcommittees to establish a building rating system for

Japan, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) (JSBC 2006).

One of the major differences with CASBEE (Institute for Building environment and energy conservation 2008) is the method in which it evaluates the building according to the life cycle. Essentially, it looks at two different aspects of the facility: the environmental load and the building performance. The environmental load can be considered as the negative impact that the building will have on the surrounding environment. The building performance would be identified as the improvement of the environmental quality within the building perimeter. By taking a ratio of these two values, it provides the user with a Building Environmental Efficiency (BEE). The resulting quantity is plotted to determine how the facility compares with similar buildings to determine the final ranking.

The CASBEE report has a specific section that reflects the anticipated CO_2 equivalent emissions for the building from construction, operation, and demolition. The embodied CO_2 emissions due to the manufacturing of the materials are included with the construction phase of the calculations. However, as a simplified model, the carbon due to construction is primarily only concerned with predominant items such as concrete and steel.

CASBEE tools are available for a wide variety of facilities such as: Pre-Design, New Construction, Urban Development, Urban Area and Buildings, Existing Buildings, Heat Island, Renovation, Temporary Construction, and Homes. Although the programs are designed for individual use, when reliable detailed results are required, a third party certification is necessary to be completed by an accredited CASBEE accessor that has specialized engineering experience with sustainable buildings.

Green Globes

The Green Building Initiative (GBI) (GBI 2011) was founded as a not-for-profit organization with an aim to bring into the mainstream building practices that result in energy efficient, healthier, and environmentally sustainable facilities. They initially worked with local Home Builders Associations to promote programs based on the National Home Building Guidelines. In 2004, the GBI recognized the value of utilizing a Canadian based learning tool, Green Globes, and adopted the program as a rating system in the U.S.

Green Globes (GBI 2010) has been working with the American National Standards Institute (ANSI) to develop a nationally recognized standard specifically that addresses the unique characteristics that make a building sustainable. Currently, the Green Globes program is only geared to New Construction and Existing Buildings; but distinguishes between Residential and Commercial type of facilities. As part of the evaluation process, Green Globes looks at: Project Management, Site, Energy, Water, Resources, Emissions, and Indoor Environment. By using a third party verification program, the design is reviewed and then an onsite inspection is conducted after the building has been constructed. Final certification is based on a percentage of the 1000 points that would be available.

One of the potential areas for points in the Green Globes evaluation is for choosing materials based on the results of a life cycle assessment. Although most valid LCA programs would be accepted, Green Globes recommends using the Athena EcoCalculator (Athena Institute 2011) to evaluate the construction of the facilities. This is a program that was developed by the Athena Institute and takes advantage of the US Life Cycle Inventory Database developed by the National Renewable Energy Laboratory. The EcoCalculator has individual sections to predict the environmental impact of a building's: foundations and footings, columns and beams, intermediate floors, exterior walls, interior walls, windows, and roofs. The program also considers a wide range of LCA parameters beyond global warming potential and carbon foot-prints such as: fossil fuel consumption, weighted resource use, acidification potential, human health respiratory effects potential, eutrophication potential, ozone depletion potential, and smog potential.

Green Star

The Green Building Council of Australia (GBCA) was established in 2002 as a not-for-profit organization with a mission to developing a sustainable property industry for Australia by supporting green building practices (GBCA 2011). They developed the Green Star rating system in 2003 to respond to the local needs with a rating system that is designed to help reduce the impact of the built environment, improve occupant health and productivity, demonstrate cost savings, and showcase some of the innovative technology for sustainability.

The Green Star rating system (GBCA 2009) is currently available to access the following types of facilities: Education, Industrial, Multi Unit Residential, Offices, Retail, and Healthcare. There are also pilot programs being developed for accessing Convention Centers, Custom buildings, and Public Buildings. The categories accessed by the rating systems include: Management, Indoor Environmental Quality, Energy, Transport, Water, Materials, Land Use & Ecology, Emissions, and Innovation. One of the factors that makes Green Star unique from the other rating systems is the way in which they apply a weighting system to the categories. Working with the individual Australian regions, the GBCA has established which criteria are most important for a geographic area and thus applied a correction factor to the category scores based on their critical environmental issues. The final score used to determine the building rating is calculated by adding together the weighted category scores plus any innovation points (which are not weighted). The maximum possible score for the weighted categories is 100 with an additional 5 points available for innovation. Although the Green Star rating system is voluntary, the GBCA requires that buildings that anticipate earning a rating of 4 or more Green Stars must obtain third party verification.

The Green Star rating system has developed their own tools for calculating the carbon emissions from the building. Although there are factors included in the building rating system for transportation and building materials, these are not included in the carbon calculations. The carbon calculation tool is based strictly on the planned energy use for the building and compares the equivalent CO_2 emissions to a reference building of similar properties within the same region.

Deutsche Gesellschaft fur Nachhaltiges Bauen

As the newest of the building rating systems, the German Sustainable Building Council (DGNB for "Deutsche Gesellschaft fur Nachhaltiges Bauen") (DGNB 2011) was founded in the summer of 2007. The intent of this group is to examine the holistic effects of the ecological, economical, and socio-cultural aspects through the life cycle of a building. Recognizing the unique emphasis of their group, they developed a new rating system in 2009 that focuses on the environmental impact of the construction materials, the operation, and the health of the occupants. Since the DGNB initially planned to have their rating tool as an international instrument for measuring sustainability, they included members of the World GBC, the Sustainable Building Alliance, EU research teams from Open House and Green Conserve, as well as an international board of partner firms.

The DGNB certificate is awarded based upon documented achievement of points as verified by a third person auditor, architect, or planner. Similar to the other building rating systems, the DGNB certificate looks at: new/existing offices and administrative buildings, new retail buildings, new industrial buildings, new educational facilities, new residential buildings, and new hotels. A building can be certified to a level of bronze, silver, or gold based on the total performance and acquiring a certain minimum percentage of points in various fields. The rating system has specific categories for ecological quality, economic quality, site quality, process quality, technical quality, and socio-cultural and functional quality. Each of these fields are examined for the entire life cycle of the building. Additionally, each field has individual elements that can be weighted according to the individual region and requirements. A major portion of the rating system is based on the results of the life cycle analysis. The DGNB uses a program developed by GaBi to perform the carbon and environmental emissions calculations based on a partial life cycle assessment

Life Cycle Assessment

As a method for evaluating the primary elements of a process, there have arisen numerous definitions with regard to what should be included in a life cycle assessment. The International Stands Organization ISO 14040 (International Organization for Standardization 2006a) defines a life cycle assessment as:

> a technique for compiling an inventory of relevant inputs and outputs of a product system; evaluating the potential environmental impact associated

> with those inputs and output; and interpreting the results of the inventory and impact phases in relation to the objective of the study

The United States has a slightly different perspective, the EPA considers a life cycle assessment to be the “cradle-to-grave” analysis of any industrial system (Scientific Applications International Corporation (SAIC) 2006). This process begins with the extraction of raw materials from the earth and continues until all the materials are returned to the earth. As we will later see, the extent of the definition will make a difference in how much information is processed. For example, using the EPA definition, all materials would be considered, whereas the ISO definition would only involve relevant elements.

In performing an LCA, all processes that have any impact on the product are considered, such as transportation, energy, repairs, and replacement parts. This method provides a full comprehensive look at everything that is impacted from the time the product is being created, through its usage, and finally what happens for disposal. What makes life cycle assessments more unique than a traditional energy or material balance is that it encompasses all the environmental impacts and releases or consumption of bi-products. With this vast amount of information concerning the full impact of a process, decision makers can more accurately evaluate the consequences and select less adverse options.

Cole and Sterner in their research on Life Cycle Costing (Cole, Sterner 2000) start by looking at the significance of performing a life cycle analysis. The following is their statement concerning the applicability of this method:

> Environmental responsibility requires taking a long-term view, understanding that the initial design decisions have profound impacts over a building’s life. Life-Cycle Assessment (LCA) methodologies have emerged as a means to profile the environmental performance of materials,

> components and buildings through time and have been generally accepted within the environmental research community as the only legitimate basis to compare competing alternatives. They have successfully entrenched the notion of an extended time context for examining the environmental characteristics of buildings beyond the short horizons that dominate current design and construction.

History

Life cycle assessments were initially used as a tool to optimize energy consumption. Perhaps the first documented cumulative energy requirement report was provided by Harold Smith at the World Energy Conference. In the EPA document on "Life Cycle Assessment: Practices and Principles" (Scientific Applications International Corporation (SAIC) 2006), they explain how the early assessments were called Resource and Environmental Profile Analysis (REPA) performed in the late 1960 and early 1970s to look at what materials were used and how much energy was needed in manufacturing processes. The Coca-Cola Corporation and Mobil Corporation were some of the forerunners of this program. In 1969, Coca Cola may have been the first company to perform a traditional LCA when they conducted a multi-criteria study that looked at the raw material extraction, manufacturing, and even disposal processes for the packaging material. In the late 1970's as a result of the oil crisis, these studies were further focused on the energy consumption for the production of fuels and labeled as Full Fuel Cycle Assessments (FFCA). In many cases this technique was successful in demonstrating that some of the bio-fuel technology of the time was actually using more energy than what would be produced.

During the 1980's, as the oil crisis lessened, the need to perform detailed energy analysis began to fade. However, in 1985 an Environmental Directive was issued in the European Union to address the pollutants used in the food industry. In particular, they were required to report on the energy, raw materials, and waste generation due to liquid food containers. Later, in 1988, as the environmental movement was starting to take hold, the need to understand the waste generation streams caused a resurgence of the LCA process (Kotaji et al. 2003).

At the time, the developments of LCAs were being done without regulation and some broad claims were being made based on the results. As LCA's were becoming more popular and recognizing the need to provide some guidance on the approach and application of LCA, the first attempt at an LCA standard, "A Technical Framework for Life Cycle Assessment" (Fava 1994) was published in 1994 by the Society for Environmental Toxicology and Chemistry (SETAC). This document provided guidance for LCA practitioners that included inventory assessment, impact assessment, and improvement analysis.

In order to perform an accurate LCA, the user needed to know some details on the material and the applicable manufacturing process. By March of 1992, as a result of the UN summit in Rio, the first legislation on Eco-labels was passed in the European Union to ensure that valid assessments had been performed and accurately portrayed the environmental characteristics of the particular products. Cole (Cole 1999, Cole 1999) talks about some of the problems in Eco-labels as:

> …often inaccurate or misleading ("recyclable", "eco-friendly") and as a result consumer confidence suffered. Many governments or third party organizations responded by assuming responsibility for eco-label certification processes in order to ensure validity of labels

From 1997 through 2002, the International Organization for Standardization (ISO) began releasing the ISO 14040 series of documents as part of the ISO 14000 Environmental Management Standards. The ISO 14040 series expands on the SETAC format and provides clarification for LCA methodologies, assessments, and interpretation. By 2002, the United Nations joined with SETAC to develop the United Nations Environment Programme (UNEP) Life Cycle Initiative in order to promote an international partnership in LCA initiatives. Currently SETAC maintains an advisory role with regards to LCA and the ISO standards have been accepted as the definitive guidance in the international arena.

The ISO 14000 series is responsible for Environmental Management and specifically designates sections 14040 – 14044 to the guidance on Life Cycle Assessment. ISO 14040 (International Organization for Standardization 2006a)provides the details on the principles and framework for a LCA. ISO 14041 (International Organization for Standardization 2006b) deals with goal and scope definition along with conducting an inventory analysis. ISO 14042 (International Organization for Standardization 1997) covers the details of a life cycle impact assessment. And ISO 14043 (International Organization for Standardization 2000) provides information about life cycle interpretation.

In the inventory stage, LCA will provide an inventory of emissions of substances and the consumption of resources due to the process being studied; it is useful to combine these chemicals into categories that can provide more information relative to the environmental impact. This type of grouping the resources is referred to as Life Cycle Impact Analysis (LCIA). By applying established LCIA techniques, it is possible to estimate what impacts a process will have without having to perform individual detailed impact analysis for each process. Since different environmental regulatory bodies have established their own parameters for grouping impacts, there are a variety of methods for LCIA.

In order to maintain the validity of the research, a particular standard should be followed for the LCA. Currently the ISO 14040 series have been accepted as the standard. In fact, the Environmental Protection Agency references the applicable ISO standards in their regulations regarding LCA development (EPA 2008). As of today, LCAs have become more standardized and rigid requirements exist for documenting the sources of data and information. The main criteria are to select a particular framework for performing the LCA and then collecting data and analyzing the information in accordance with the specific protocol. One of the great variables in conducting LCAs is due to the amount of information that is available relative to the impacts of a particular process. In some instances, a full range of constituents ranging from chemical to social consequences have been modeled. However, other situations may only have limited data available and be constrained to only one particular ecological impact category such as global warming potential (GWP).

Carbon Footprinting

William Rees has been accredited with first developing the idea for ecological footprinting. In an article he prepared with Wackernagel (Rees, Wackernagel 1996) in 1996 they state:

> Since most forms of natural income (resource and service flows) are produced by terrestrial ecosystems and associated aquatic ones, it should be possible to estimate the area of land/water required to produce sustainably the quantity of any resource or ecological service used by a defined population or economy at a given level of technology. The sum of such calculations for all significant categories of consumption would provide a conservative area-based estimate of the natural capital requirements for that population or economy. We call this area the population's true "ecological footprint."

Although ecological footprint is typically associated with the wide spectrum of impacts resulting from human activity, recently a newer concept has arisen in which carbon is isolated as the primary chemical for consideration and the term carbon footprint has been developed. In an article prepared by A.J. East, (East 2008) he points out that the primary differences between ecological footprint and carbon footprint are that carbon footprint focuses on the processes related to the emission of CO_2 and other greenhouse gases. Additionally, although ecological footprint could be considered a measure of the regenerative capacity of the environment measured in area of productive land; most of the definitions dealing with carbon footprint are quantified in a physical quantity relative to the equivalent amount of carbon dioxide.

Several researchers have examined the wide dispersion between some of the definitions that exist with carbon footprinting and subsequently how to measure its quantities. Wiedemann and Minx, in their 2008 report (Wiedmann, Minx 2008), point out that over a dozen various definitions exist concerning carbon footprint. Some of the variations can be attributed to: does it include other greenhouse gases, does it include carbon that is not a greenhouse gas such as CO, what are the boundaries for measuring the system, is it only direct emissions, or due to full life cycle process. As would be expected, these uncertainties can have a dramatic impact in the results of carbon calculation tools. Kenny and Gray (Kenny, Gray 2008) looked at 6 various carbon calculation tools and concluded that:

> The information provided by these widely used carbon footprint models are inconsistent and often contradictory. There are no standards available in relation to where the emission factors are sourced or for what fuels and activities each model should cover resulting in anomalies. To enable individuals to calculate their carbon dioxide emissions accurately information should come from a credible and regularly updated source, be

> transparent and country specific. All transportation, energy and fuel types need to be available as options within models, and these vary significantly between countries. Internet models do not include data on other greenhouse gases such as CH4 and N2O that leads to a small, but potentially significant, underestimation of emissions in terms of carbon dioxide equivalents (CO_2e). Currently available models provide estimates rather than accurate measures of CO_2 emissions. There is an urgent need for comprehensive and reliable models that can accurately determine individual and household primary carbon footprints.

Pandey et.al (Pandey, Agrawal & Pandey 2010) echoed these sentiments in a similar paper concerning the discrepancies between carbon footprinting techniques in LCIA methods. A conclusion drawn by this research was that "Carbon footprinting is intended to be a tool to guide the relevant emission cuts and verifications, its standardization at international level are therefore necessary."

One of the primary groups for developing guidance on carbon footprinting is the UK based Carbon Trust. The Carbon Trust organization is self-described as "a not-for-profit company providing specialist support to help business and the public sector boost business returns by cutting carbon emissions, saving energy and commercialising low carbon technologies." Their research has led "to in depth analysis of key issues to inform businesses and policy makers on how to address climate change and harness the economic benefits it presents." (The Carbon Trust Ltd. 2011)

Despite the attempts to make the carbon footprinting methods consistent, there still remains a great deal of variations based on the needs of the particular activity performing the carbon research. As a result of this dispersion, different nations and regulatory bodies are developing their own standards relative to dimensions that should be included to substantiate any claims about the level of accuracy of the LCA (Bare 2002). But ultimately the decision on the level or method of evaluation is responsibility of the organization conducting the research in accordance with their particular scope and goal. The primary consideration is that an appropriate tool is used and the methodology is in accordance with accepted practices.

Life Cycle Impact Assessment

Shah et al. (Shah, Debella & Ries 2008) studied the differences between four of the most popular LCIA methods (CML2001, Eco-Indicator 99, TRACI, and EDIP2003). Their research highlighted the fact that differences in the procedures and properties that were being analyzed by the various LCIA methods could result in significant variations in the outcomes. This idea was also seen in a research document by Dryer et.al, (Dreyer, Niemann & Hauschild 2003) in which three LCIA methods (CML2001, Eco-Indicator 99, and EDIP97) were used to analyze a lacquer plant. Their research demonstrated that CML and EDIP had similar results; but Eco-Indicator had dramatic differences based on its diverse framework and model inclusions. Both of these studies determined that each of these methods had some form of deficiency that could result in misleading results. In essence, LCAs must be continually evolving as research improves the understanding of the interactions of chemical properties in order to provide a result that is more precise and valuable for decision making.

Despite the standardization provided by the ISO 14040 series, there is still a great deal of latitude permitted in developing life cycle assessments. In particular, this becomes clear while reviewing the methods and results from a variety of research projects that attempt to document the life cycle impact of products and processes. Even though the projects may start by using the ISO standards as their initial criteria, the variability in the data collection and research objectives will often result in very diverse findings.

Tool for Reduction and Assessment of Chemical Impacts

The EPA, while conducting numerous LCA studies in 1995 (Bare 2002), determined that they needed to develop a better tool for evaluating the results of the assessments that specialized on pollution prevention and sustainability. They performed a literature review of the current technologies to determine the applicability, sophistication, and comprehensiveness of the existing techniques. Since there were no systems available that met the criteria for the particular situations that apply in the U.S. for all categories of consideration, the EPA decided to create their own tool. The Tool for Reduction and Assessment of Chemical and other environmental Impacts (TRACI) was released with the intent of being simplified for individual users to operate on their home computers. The following table provides a list of monitored parameters from the TRACI program: (Bare et al. 2003)

Table 2-1. Tool for Reduction and Assessment of Chemical Impacts (TRACI) Life Cycle Assessment data

Categories	Elements
Depletion	
	Abiotic resources
	Biotic resources
	Land use
	Water use
	Abiotic resources
Pollution	
	Ozone depletion
	Global Warming
	Human toxicology
	Eco-toxicology
	Smog formation
	Acidification
	Eutrophication
	Odor
	Noise
	Radiation
	Waste heat

Life Cycle Assessment for Buildings

A significant amount of research has been conducted based on using LCAs to evaluate buildings. As early as 1997, Kaltschmitt et al. (Kaltschmitt, Reinhardt & Stelzer 1997) were looking at LCA as a tool for measuring the impacts due to alternative energy sources such as bio-fuel. Suzuki & Oka (Suzuki, Oka 1998) developed a methodology in 1998 based upon CO_2 emissions from office buildings in Japan. In 2002, David Shipworth looked at the various methods being employed to examine life cycle analysis in order to meet the Kyoto Protocol. He identifies that a major problem encountered in conducting LCA's is due to the limitations in calculating the embodied energy levels of materials used in construction. In Mr. Shipworths paper, "Stochasitic method of performing LCA", (Shipworth 2002) he recommends using random sampling of the inputs to the material supply chain in order to expand the database and provide more accurate results for determining the optimum choice for materials and processes.

Some of the earliest assessments of buildings were predominantly treated as a study of the materials similar to the method used for other short term industrial processes. In 1981, Stein et.al. (Stein et al. 1981) performed a study for the US Department of Energy in which they specifically looked at building construction materials relative to embodied energy. The American Institute of Architects has been credited with one of the first attempts at documenting the building materials from a life cycle assessment perspective in their 1996 publication of the Environmental Resource Guide (Dempkin 1996). Although, in order to simplify the process and avoid the difficult issues of disparate variables, the guide only considered the relative comparison of materials and failed to give a detailed analysis of environmental impacts to permit a final life cycle inventory for the structure.

With the encouragement of the Kyoto Protocol (Gugele et al. 2002) to reduce the greenhouse gas emissions, many industrial nations became more active in documenting their material processes and LCA data was more readily available. As the data became available for individual processes more research was conducted relative to the heightened interest in the environmental impacts of the material production processes. In particular, some building owners started looking for construction alternatives that selected materials with less detrimental ecological significance. This philosophy of looking at the construction materials is expanded on by Scheuer et al. (Scheuer, Keoleian & Reppe 2003) in their paper on evaluating the embodied energy of building materials: In particular, this research recommends evaluation of particular construction items with regards to replacement time in order to plan for the most optimum components.

> Clearly high replacement rates of materials with high embodied energy will have a greater impact on life cycle performance. The influence of renovation material choices and schedules on the embodied energy of a building are not typically considered in the design stage of a building, but as these results indicate designing with renovation burdens in mind could diminish long term embodied energy burdens.

In a 2008 article, Dimoudi and Tompa (Dimoudi, Tompa 2008) look at two buildings relative to embodied carbon in the construction materials to determine the effect of the components other than concrete and steel. Their study indicated the importance of going beyond just material selection; but also looking at the interaction of various components that make up systems as seen in the following:

> As far as construction practices are concerned, additional criteria should be considered like the lifetime of building materials, the compatibility of the lifetime among the layers' building materials, the kind of assembly of different materials and of the different layers, their maintenance needs over the building life cycle.

Due to the format following other predominant LCA methodology and the expansive research available on this type of study, there have been numerous reports of buildings that follow a similar method but with an emphasis on energy usage as the monitored resource. For the most part, these research projects have considered time to be relatively static in order to preclude more complex calculations dealing with temporal variations. The primary recognition they provide for variations in impact over time is to factor a service life of 50 or 60 years and then extrapolate the results over this period. Examples of this type of research involving these type of temporal constraints can be seen by: Adalberth (1997) (Adalberth 1997), Chen et al.(2001) (Chen, Burnett & Chau 2001), Lollini et al. (2006) (Lollini et al. 2006), and Sartori & Hestnes (2007) (Sartori, Hestnes 2007).

Model Complexity

As the need for more accurate results in environmental impacts becomes necessary, the research has expanded to include some of the more challenging issues dealing with temporal variations in conjunction with material processes in performing life cycle assessments. Because of the unique complexity of the built environment, it lends itself ideally to the more advanced methods of life cycle assessments. Luetzkendorf & Lorenz (Luetzkendorf, Lorenz 2006) have the following comment on the impact of these developments on LCAs:

> “The demand for building assessment results no longer stems from a predominantly scientific interest, nor is it focused solely on environmental aspects. The shift from green to sustainable building approaches and the linkage of assessment results with far-reaching financial aspects (e.g. taxation, lending and insurance, valuation and reporting) will impose stricter requirements in terms of the traceability, liability, comparability, certainty and extent of building assessments. By demonstrating how energy and mass flows or carbon dioxide emissions are caused through individual actors’ decisions and actions, LCA-based tools will potentially increase

> actors’ motivation as well as their willingness and ability to take self-responsibility. Furthermore, assessment results of LCA based tools can be used for aggregation purposes at the community or building stock level

However, this has prompted intensive discussions within the academic community concerning the definition of a functional unit for a building and what factors should be included or excluded from life cycle assessment methodologies.

In the Verbeeck & Hens (Verbeeck, Hens 2010) research on life cycle inventory’s, they mention that:

> probably because of the complexity of the course of life of a building, researchers in the past often opted for building materials, building products or building components as subject for LCA research … decisions based on isolated LCA for materials or components might lead to unexpected secondary effects when the materials or components are applied in buildings without taking into account their impact on the performance of the building as a whole.

In addition, Borg et al. (Borg, Paulsen & Trinius 2001) have described in detail some of the difficulties associated with modeling a building’s life cycle.

> Applying and developing the LCA methodology to the context of the building sector makes several building-specific considerations necessary. These considerations originate in the fact that some characteristics of products in the building sector different considerably from those of other industrial sectors. The largest difference is that the service life of a building can stretch over centuries rather than decades or years, as for other industrial products‘ service lives. The long service life of buildings has a consequence that it is difficult to obtain accurate data and to make relevant assumptions about future conditions regarding recycling. These problems have implications on the issue of allocation in the building sector in the way that several allocation procedures ascribe environmental loads to users of recycled or reused products and materials in the future, which are unknown today.

Erlandsson and Levin (Erlandsson, Borg 2003, Erlandsson, Levin 2005) use backcasting as a method to evaluate building impacts and determine that treating buildings as functional units that vary over time as opposed to products can provide more information on the overall environmental impact. Beyond heating/cooling, water and wastewater are also significant factors that need to be considered in overall life cycle of the facility.

Salazar and Sowlati's research (Salazar, Sowlati 2008) of window systems proved an important relation between the embodied energy and service life. In summary, they determined that both factors must be considered in order to accurately reflect the most environmental friendly product. By examining window frame materials they were able to demonstrate that despite the wood frame windows having less embodied energy, over the life of the building they would need to be replaced more often than frames of PVC or aluminum. The aggregate effect for the building was that the PVC or aluminum windows would actually demonstrate less environmental impacts and be a wiser choice. In essence, buildings are very complex systems with a large number of variables to be considered in performing an accurate life cycle assessment beyond just treating them as a product stream.

This idea has seen to the growth in LCA tools that are designed specifically to look at individual materials or systems and compare them with other options to determine which product will have the least impact due to a variety of environmental factors. In the development of these analysis tools, Trusty (Trusty 2000) classified the models into two types: Level 1 tools and Level 2 tools. A Level 1 tool is one that looks at an individual product such as gypsum wall board or plaster and compares them based on their life cycle impact assessment properties. BEES is a common tool in the Level 1 category (Lippiatt 2007). A Level 2 tool is one that looks a building system, such as an interior wall, and has all the individual components such as studs, insulation, and sheathing built into the calculation automatically. These tools are designed for analyzing a whole building and cannot be used for individual components. Athena is a typical Level 2 tool.

Another method of distinguishing between different LCA tools is by the level of experience required for the operators. As many of the tools only permit the user to input parameters relative to their facility, they could be considered applicable for lay individuals that do not require extensive understanding of the life cycle assessment process. However, there are also LCA tools in which the user has the ability to alter the configuration and input specific constituents. The simplified models only permit analysis of the loaded data fields while the more complex LCA tools allow the operator to use preloaded data and also input their own data from other sources.

Currently there are a number of tools available on the market that claim to be able to provide the “best” life cycle assessment. Erlandssen & Borg (Erlandsson, Borg 2003) performed a review of the some of the most popular tools which included: Athena by the Athena Sustainable Materials Institute, Envest by the UK’s Building Research Establishment, Eco-Quantum 3 by IVAM, BEAT 2000 by SBI, and BEES from the NIST. As many of these LCA tools are from various international regions, they may have different evaluation processes for their data and thus varying levels of results. It is important to understand the source of data from each of these tools in order to ensure that the information will be accurate. In summary they determined that each of the tools was designed for particular circumstances and specific attention relative to the goals of the life cycle assessment are critical in ensuring that the appropriate tool is chosen. Failing to research the tool and understand its applicability and limits is likely to result in erroneous calculations and not provide an accurate representation of the building being modeled.

Mirza's 2006 article (Mirza 2006) on durability and sustainability of infrastructure takes a bit more detailed look at the building life cycle and encourages that the assessment should examine each phase of the building life cycle individually. By performing backcasting, the designers are expected to plan for the various impacts that could be expected as the building is designed, built, operated, and finally demolished. Their report states:

> Proper design, operation, and management of infrastructure must deal with every facet of its service life, ranging from conception, feasibility studies, design, construction, operation, maintenance, repair and rehabilitation, and finally decommissioning and disposal of the system after it has outlived its useful life. Every step of these considerations must be guided by overall socioeconomic and environmental concerns; in summary, they must be guided by the principles of sustainable development, which embrace the issue of embodied energy in the materials, construction, and both initial and recurring maintenance.

Echoing this perspective, Erlandssen & Borg (Erlandsson, Borg 2003) also support the idea of whole building analysis based on separately computing the impacts at the different phases in the life cycle. They describe research that has been conducted in Sweden, Germany, USA, France, and New Zealand that indicates the value of this framework for the development of individual models. Each phase of the building life cycle would have their own specific model and parameters allowing them to respond more precisely to the particular situations relative to the phase dynamics

Building Life Cycle Stages

Based on the premise of finding the most comprehensive method for calculating the buildings total ecological impact, the individual life cycles should be evaluated to determine their respective contributions. One of the parameters that carries across the various phases of a building life is the energy usage, as there is energy required in the material production, the actual construction of the facility, the standard operations, and finally in the demolition process. Reddy & Jagadish (Reddy, Jagadish 2003) describes this idea in:

> Energy in buildings can be categorised into two types: (1) energy for the maintenance/servicing of a building during its useful life, and (2) energy capital that goes into production of a building (embodied energy) using various building materials. Study of both the types of energy consumption is required for complete understanding of building energy needs (2003).

Research on the operational energy demands of a building have been performed by a number of scholars and include: Cole & Kernan (Cole, Kernan 1996) and Fay et.al. (Fay, Treloar & Iyer-Raniga 2000). One of the common results of these studies has indicated that the majority of energy is actually consumed during the operational phase of the building. The challenge that arises out of this fact is that the operating life time of the facility is one of the most speculative factors, as previously discussed. The Athena institute (Athena Institute 2006) alludes to this difficulty in their statement:

> Defining or judging service life has been problematic for the developers of green building rating or assessment systems, and few tackle the subject from a holistic perspective. Indeed, while much information exists worldwide on building and material service life, building construction, and green building systems, there is little discussion of all three subjects as an interrelated whole

In an attempt to work within this challenge, each of the construction phases will be evaluated and thereby increasing the confidence in individual phases can improve the overall accuracy of results. As ISO standards require (International Organization for Standardization 2006a), documentation of areas with speculative results will be provided and affect the level of sensitivity of analysis.

Construction Phase

In the worldwide construction industry there are two popular methods for categorizing construction materials (Management computer controls 2010). In the United States, the specifications are organized according to the Construction Specification Institute (CSI) Masterformat (Management Computer Controls 2010). The Masterformat is comprised of 48 Divisions of which the first 10 are the most common for all construction projects. The divisions are based on the typical construction materials such as: concrete, masonry, metals, wood, plastics, etc. Essentially, all construction materials of a particular category would be included within a particular division. For example, all concrete in the building including footers, slabs, decking, cast in place, etc; would all be part of CSI division 03.

The other predominant method of organizing construction materials is via the Uniformat divisions (Management computer controls 2010). The Uniformat system defines the standard classifications based on eight building levels and related sitework. The major levels include elements such as Substructure, Shell, Interiors, Services, Equipment and Furnishings, Special Construction and Demolition, Sitework, and General. Subsets for the major group elements include individual group elements that provide more detail on the levels. For example, the substructure element will include sub-elements for foundations and basement construction. These sub-elements are divided further into the particular construction elements such as standard foundation, special foundation, and slab on grade. Each of these elements will include all of the materials needed to construct the appropriate item, such as the steel, concrete, and thermal protection will all be included with a particular element. However, these items would have been in their own separate divisions in the Masterformat system.

Each of these methods has their own advantages and disadvantages. The Masterformat is ideal for categorizing the quantity of specific material needed on a job site. On the other hand, the Uniformat method is best for quantifying what is involved in a particular phase of the construction. If the project manager is looking for the quantity of a specific material, the Masterformat can readily provide the information; but it is more difficult to determine what items are included in a particular system. In summary, the Materformat will provide information on what the construction item is and Uniformat will provide information on where the construction item is.

Construction materials are commonly standardized depending on ANSI standards in order to permit integration of varying products. Due to their standard criteria, weights of routine construction materials are available from the Construction Specification Institute (Carson 1989). With this standardization of materials, it facilitates the data collection or basic elements relative to their life cycle impact assessment.

There have been numerous studies into the advantages of various construction materials relative to their life cycle carbon emissions and efficiency in heat transfer. An example of this kind of study can be seen in an analysis of timber used in building construction, performed by Andy Buchanan (Buchanan 2008). He summarized that although the embodied energy within the wood frame buildings is less than embodied energy for steel or concrete, this advantage was offset by the poor insulating qualities of the structure and subsequent increase in energy required for conditioning the spaces. However, a significant difference was noted when using wood as a renewable energy source as opposed to fossil fuels due to the rapidly renewable properties and the reduction in CO_2 emissions. The analysis summarized that more research needs to be conducted to improve the efficiency of the wood frame structures and increase the insulating factors. A similar report by Peterson et al, (Petersen, Solberg 2002) demonstrated that the use of steel beams resulted in three to four times more energy than the manufacture of glulam beams. Additionally, the waste handling of the glulam could also help offset fuel costs if it were burned for energy or heat. Naturally, the parameters such as travel distance and availability of raw materials used in the manufacturing of the materials play a significant role in the determining of the environmental impact. Overall, an accurate LCA is critical to understand the full impact and assist in the decision process.

Unlike smaller manufacturing processes in which the final product is essentially disposable, a building is comprised of a variety of materials that can be recycled or reused in numerous subsequent structures or processes. In their 2007 research, Schultman and Sunke (Schultman, Sunke 2007) explain some principles behind determining which materials should be considered for reuse or recycling and the importance of including this evaluation in the design stage. They state that: “the reuse and recovery of building components and materials is “advisable” provided that a positive eco balance is supported by not increasing the gross sum of energy use”

One of the challenges in dealing with materials and energy flows in construction is allocating percentages of resources to their appropriate impact area. For example, when recycled steel is used in the production of steel for a construction project, what percentage of the impacts can be attributed to the recycled material and what is due to raw material? This allocation of resources becomes further exasperated when you consider that often materials flows need to be considered for decades into the future.

Borg et al. (Borg, Paulsen & Trinius 2001) provide the following recommendation to address this issue:

> The long service life for buildings, building materials and building components, is associated with the introduced concept of a virtual parallel time perspective proposed here, which basically substitutes historical and future processes and values with current data. Further, the production and refining of raw material as a parallel to upgrading of recycled material, normally contains several intermediate products. A suggestion is given for how to determine the comparability of intermediate materials. The suggested method for allocation presented is based on three basic assumptions: (1) If environmental loads are to be allocated to a succeeding product life cycle, the studied actual life cycle has to take responsibility for upgrading of the residual material into secondary resources. (2) Material characteristics and design of products are important factors to estimate the recyclable amount of the material. Therefore, a design factor is suggested using information for inherent material properties combined with information of the product context at the building level. (3) The quality reduction between the materials in two following product life cycles is indicated as the ratio between the market value for the material in the products.

Operation Phase

With typically 80 – 90% of the overall carbon emissions being attributed to the operation phase, it is critical to fully understand what are the components that contribute to this factor. The Common Carbon Metrics (Sustainable Buildings and Climate Initiative 2006) from the Sustainable Buildings and Climate Initiative establish the primary factors to be considered when evaluating the carbon emissions from a building. The documentation considers three scopes of emissions for evaluating the processes and calculating the environmental impact:

> Scope I - Direct
>
> Direct on-site emissions result from sources within the boundaries of the building or building stocks under study that can be quantified by the reporting entity, including stationary combustion emissions, process emissions and fugitive emissions. Direct emissions are typically produced from the following types of activities: Stationary combustion emission from generation of on-site electricity, cooling, heat or steam, Fugitive emissions from intentional or unintentional releases, Fugitive emissions are not

physically controlled by the reporting entity, but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets and so on.

Scope 2: Indirect on-building-site

Indirect emissions are a consequence of the activities that occur outside the building site, for example activities at a community power plant for providing the energy consumed on-building-site. Scope 2 emissions included in the Common Carbon Metric are all GHG emissions associated with the overall generation of purchased energy such as electricity or steam, for ventilation or heating or the provision of any kind of fuels for heating.

Scope 3: Other Indirect

Scope 3 addresses indirect emissions not covered in Scope 2 activities that are relevant to building performance that are not included in the Common Carbon Metric. Examples of these emissions include: Upstream and downstream emissions related to the before-use phase of the buildings, e.g. raw • material extraction for metals. Transport related activities in vehicles related to all stages of the building life cycle . After-Use phase activities such as: Re-use, Recycling. Thermal recycling, Waste disposal processes.

Similar to the construction phase, the operation phase must also deal with the issue of resource allocation. The same principles will apply for determining what percentage of resources to distribute among the factors; but additionally, the utilities and other routine procedures need to include these same measures.

Utilities. The U.S. Department of Energy Information Administration (EIA) is a subgroup under the U.S. Department of Energy that is responsible for independent statistics and analysis. As part of their responsibility, the EIA conducts surveys of the commercial building stock at scheduled quadrennial intervals and releases a report entitled the Commercial Building Energy Consumption Survey (CBECS). The last assessment conducted in 2007 proved statistically inaccurate data and thus the 2003 version of the database is the most recent to be released. As part of the survey, the EIA collects data from commercial buildings regarding energy consumption, costs, and energy related building characteristics. Since the survey can be sort based on a variety of categories, this provides a very useful tool for determining the average of various parameters in particular regions or even nationwide (U.S. Energy Information Administration 2011).

Although the CBECS can provide a general range of typical buildings within a region and classification of facilities, it does not give the details necessary to assist in reducing the energy demands of the building. From a facility owners' standpoint, the most common method of analyzing the utilities in the building industry is through life cycle energy assessments. Due to direct correlation between energy use and costs, owners and facility managers see a direct impact on higher energy usage that results in an added motivation to reduce consumption. Although this may be the most studied aspect of the construction process, a research paper by Ball (Ball 2002) points out the interesting fact:

> The holy grail of low energy has mesmerized many assessments of ecological design to the virtual exclusion of other environmental impacts. Energy is probably the most easily measured and addressed in the construction industry but it is by no means the only factor of sustainability. Indeed, it is probably the very fact that energy is an easily quantified commodity that it is such a popular measure of the environmental credentials of a material or building

Potable water. Perhaps the next most recognized quantity in normal building operations has to deal with potable water usage. Although often overlooked in carbon emissions calculations, it is important to consider the energy and resources required to treat and distribute clean water. Additionally, a significant more amount of energy and resources are required afterwards to handle the wastewater processing. John Dryden (Dryden 2006) performed specific life cycle analysis on the water/ wastewater processes in order to quantify the impacts and look at the alternatives that may be available for using localized processing facilities as opposed to centralized distribution systems.

Maintenance. One of the more complex aspects to quantify for a buildings operation phase is the routine and specialized maintenance. A significant amount of research has been conducted by the US Army Corps of Engineers with the Whitestone Research Group (Whitestone Research 1995; 2009) to attempt at planning the amount of resources required to maintain a facility. The primary focus of this document is to help in planning for life cycle costing and thereby assist in the decision process for the purchase of new equipment. By using this type of reference guide it is possible to correlate the material and energy usage in routine maintenance and replacement of products to a life cycle impact assessment. Although it is difficult to be precise with anticipations of future maintenance requirements other than scheduled preventive maintenance, there is significant historical record to indicate results with a relatively high level of confidence.

Transportation. The U.S. Environmental Protection Agency developed a series of guidance documents (EPA 2005) to address the carbon emissions that are associated with vehicle usage. They are intended to assist anyone in estimating the impacts of petroleum based fuels on air pollution. The primary chemical that is monitored is carbon dioxide (CO_2). From the "Inventory of U.S. Greenhouse Gas Emissions and Sinks" the EPA estimates:

> to calculate the CO_2 emissions from a gallon of fuel, the carbon emissions are multiplied by the ratio of the molecular weight of CO_2 (m.w. 44) to the molecular weight of carbon (m.w.12): 44/12
>
> CO_2 emissions from a gallon of gasoline = 2,421 grams x 0.99 x (44/12) = 8,788 grams = 8.8 kg/gallon = 19.4 pounds/gallon

During the operation phase there are several things an owner or building manager can do to help reduce the emissions and environmental impact. In order to provide an accurate indicator of the full impact on the ecology these offsets should be included. Tracking these factors also provide a valuable resource for helping to make decisions on effective means to reduce the carbon footprint.

Renewable energy. Renewable energy can be attributed to either on site production or to centralized power plants. Additionally, it is possible to purchase renewable energy credits to offset the carbon emissions due to fossil fuel power generation. Since renewable energy is normally significantly cleaner than conventional fossil fuels and does not deplete limited resources, it is understandable why there would be encouragement to use these techniques. Although on site renewable energy (Hostetler, Escobedo 2010) production is not always economically feasible, the current electric grid system has effectively made renewable energy accessible to the general public. Thus whenever renewable energy credits can be purchased to offset power generation in one location, it effectively has a ripple effect to reduce the amount of power generation from another utility plant and create an overall reduction in fossil fuel usage (Scheuer, Keoleian 2002). Due to the variability in alternative energy generation techniques, not all methods have the same life cycle impact. NIST reports the following concerning renewable power sources:

> The environmental impacts of renewable power sources are not all equivalent. For example, in the manufacture of each system there are different burdens associated with resource extraction and material production… different combinations of grid and renewable energy sources will have different environmental impacts. An important measure of energy system environmental performance is the Fossil Energy Ratio (FER), which is the energy (generally electrical) output divided by the primary fossil energy input… One approach for a minimum criteria for a "sustainable"

energy system is an FER greater than 1 because at that point energy production exceed depletable energy resource consumption.

Landscape. One of the most environmentally friendly methods for sequestering carbon is through the planting of vegetation. Research ((Newell, Stavins 1999), (Hostetler, M. 2010), and (Hall 2001)) has been conducted that can predict the amount of carbon uptake based on the size and types of trees, plants, or shrubs. However, for lawns, consideration must be given to fuel and energy usage to maintain the grounds and keep them mowed. Additionally, factors such as fertilizing and insect treatment can contribute significant detrimental factors due to eutrophication and air/water pollution. Another impact to be considered is the irrigation system and the source of water. If captured rainwater or grey water is used, there may be a beneficial factor due to reducing the sewage/storm water. However, when potable water is used for irrigation, there will be an associated increase in the energy demands in conjunction with the water to account for the process and distribution of the water. Overall, careful consideration needs to be provided for the collateral effects due to landscaping and a thorough life cycle assessment should be conducted to estimate the impacts.

Demolition Phase

Although many research projects ((Sustainable buildings and climate initiative 2006), (You et al. 2011), (Papadopoulou et al.)) have indicated that the demolition phase has the least impact on the carbon emissions of the building, it is still significant with regards to life cycle impact assessment in that it can have a dramatic impact on air/water pollution, land emissions, and eutrophication. The primary energy consumption during the demolition phase occurs due to the equipment used to deconstruct the building and the transportation of the material to either landfill or reclaim facility.

Landfill. The material in the landfill can have variable impacts on emissions depending on the chemical composition (You et al. 2011). Some material is biodegradable and can release fugitive emissions. Other wastes are inert and occupy landfill space for decades and longer resulting in landfill footprint emissions. The landfill footprint emissions are essentially a loss of ecological conditions due to space occupied by the landfill. Due to leachate and air born contaminants, a landfill can have significant environmental impacts on the ground water, soil conditions, and air quality for a wide surrounding region.

Recycling and reuse. The Deconstruction Institute (Guy, Gibeau 2003) estimates that:

> In order to sustain human society into the next century, resource efficiency will have to increase by a factor of 10. The materials salvaged through deconstruction help replenish the construction materials market, rather than add to the amount of waste in landfills. In fact, studies indicate that deconstruction can reduce construction site waste by 50 to 70 percent.

Obviously this provides a significant incentive for reusing or recycling construction waste. As life cycle assessments conducted by Brown & Buranakarn (Brown, Buranakarn 2003) have indicated, there is also a significant advantage for the environment in recycling certain products that require more energy to extract and less energy to reuse. They state that: “The analysis of materials suggested that recycle of wood may not be advantages on a large scale, but metals, plastic, and glass have very positive benefits” Although there is still energy used in the transportation and processing of the reused items, it is normally offset by the significant reduction in the embodied energy of the new product.

The EPA in their Lifecycle Construction Resource Guide emphasizes the importance of planning for material reuse or recycling during the design phase. This applies both to new buildings and requiring them use reuse or recycled products as well as designing a building for the end-of-life and specifying that the construction has been designed with recycling the material as it is disassembled.

Incineration. The State of Oregon Department of Environmental Quality (Quantis, Earth Advantage, and Oregon home builders association 2009) performed a very detailed life cycle analysis of building deconstruction that included emphasis on the incineration process. From their report it was determined that incineration is assumed to occur with partial energy recovery. Estimates were shown that up to 10% of the heat content of the materials is recaptured as electrical energy and 20% of the heat content is captured as heat energy. Thus, when calculating the overall impacts of the incineration process, despite the air and waste factors, the energy and heat factors should be calculated to determine the amount of offsets in power production. For the air and waste factors, the quantities to be considered are similar to other power generation facilities in that the age and sophistication of the equipment has a significant impact on the emissions produced.

Building Rating Systems and Life Cycle Assessment

To bring these elements all together, there have been several research projects that have addressed looking at building rating systems relative to how they measure their environmental impact. It is interesting to see the differences in some of their assessments and how they compare the various tools. Essentially, the research can be grouped into the following categories: Individual Product Evaluation and Comparison of Several Tools.

Individual Product Evaluation

David Hoff performed an analysis for the roofing industry in 2003 (Hoff 2003) in which LEED and LCA were compared to determine their benefits and limitations. One of the main disadvantages at that time was the limited LCA information available for construction materials. Durability is one of the most important items in roof construction and yet it was not given enough significance in the LEED rating system. Hoff felt that as more data became available to demonstrate the true environmental impact of material usage, it may dramatically change the way in which LEED evaluates facilities.

An evaluation of LEED was conducted using life cycle assessment Methods by Chris W. Scheuer & Gregory A. Keoleian in Sept 2002 (Scheuer, Keoleian 2002). The project was sponsored by the National Institute of Standards and Technology (NIST) to research the applicability of LEED to evaluate building sustainability. The research was primarily concerned with going through the LEED scorecard and seeing the impact as the building characteristics were changed in order to earn more LEED points and how that would impact the environmental outcome. Ideally, as the LEED points increased, the environmental impact would be reduced by an equivocal amount. Unfortunately, it was demonstrated that there was not always a direct correlation between the LEED score and an improvement in the key environmental parameters.

The USGBC has developed a research committee focusing on how LCA can become a more responsive part of LEED certification. To date, their results are limited and primarily encourage the use of LCA modeling during material selection (USGBC 2006).

Comparison of Several Tools

Several federal agencies have adopted these principles and conducted research on the effectiveness of the methods for evaluating the life cycle analysis. The global realization of the significance of this issue can be seen in the variety of countries that are participating in this research. 1n 1998, the Centre for Building Performance Research in New Zealand contracted the Victoria University of Wellington to establish an energy coefficient database for local buildings (Alcorn, Wood 1998). The Canadian Government conducted research (Department of the Environment and Heritage 2001) in 2001 analyzing the LCA for their energy production to establish the most optimum resource. American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) developed workshops in 2007 and is currently soliciting research that specializes in quantifying the carbon footprint of the built environment (ASHRAE 2007).

Department of the Environment and Heritage of Environment Australia conducted a literature review of the predominant LCA rating tools and compared them with building rating systems in their paper: “Greening the Building Life Cycle, Life Cycle Assessment Tools in Building and Construction” (Department of the Environment and Heritage 2001). This document serves more as a shopping list of available technology and does not provide any comparative analysis between the various programs. The emphasis is more that each program has its value in a specific area and does not offer any preference to tools.

Kimberly Bunz et.al. (Bunz, Henze & Tiller 2006) performed a detailed analysis of some of the most prominent building rating systems in which programs in North America, Asia, and Europe were compared relative to what areas they evaluated for sustainability. Expanding from that perspective, this research examined how various building rating systems evaluated information through the life cycle of the building. It was noted the lack of rating tools that examined the deconstruction phase although there were significant similarities in the design and operation phases. Overall, this research provides an excellent resource in looking at the categories within rating tools to determine how it compares with other nation's rating systems.

At the 2005 World Sustainable Building Conference in Tokyo, Nigel Howard (Howard 2005) presented his research on the predominant means of international building assessment. He examined the similarities between 19 various rating systems and then provided more detailed analysis on BREEAM, LEED, CASBEE, and PromisE. Although highlighting some of the variations in the techniques applied by the assessment tools, it concluded that improved conformity with better LCA tools would be necessary. Additionally, at the same conference, Kawazu et al. (Kawazu et al. 2005) performed a detailed comparison of 4 high performance buildings in Japan that had earned CASBEE ratings to see how they would qualify under the BREEAM, LEED and GBTool rating systems. Despite not looking at the carbon emissions of the buildings, the analysis determined that for "Indoor Environment", "Quality of Service", "Energy", "Resource and Materials", and "Off-site Environment" categories, the rating systems reported similar results. However, for the "Outdoor Environment on Site" category, all four of the rating systems had different results.

By using LCA models, Osman et al. (Osman, Norman & Ries 2008) were able to demonstrate the differences due to energy equipment selection that resulted in converse environmental outcomes due to Global Warming Potential (GWP) and Tropospheric Ozone Precursor Potential (TOPP) in commercial buildings. The LCA optimization model was found to be particularly useful for developing the data that was needed to select the best combination of ecological and economic criteria. By graphically plotting the results in various scenarios, the model was able to prove where tradeoffs could be taken over the entire life of the building.

In summary, despite there being numerous research projects associated with building rating systems and life cycle assessments, none appear to compare actual facilities based on their carbon emissions and simulate the results for the most popular rating systems.

CHAPTER 3
METHODOLOGY

In order to develop a model that uses LCA methods to evaluate building rating systems based on carbon footprinting, the first step is to evaluate what techniques are being applied by other international rating systems. The evaluation will look at how the various rating systems consider carbon as part of their evaluation and determine if there are methods that may be applied universally. Based on the lessons learned from the various rating systems, a LCA tool will be developed that can evaluate the full life cycle of a building for carbon emissions. Finally, a methodology will be developed that explains how the LCA tool can be used to evaluate a facility in addition to assisting in the decision process to reduce carbon emissions.

Rating System Comparison

All of the rating systems used for comparison in this report have numerous areas of specialization such as commercial, residential, health care, and educational facilities. Additionally, most of the studied rating systems have different methods for dealing with geographic regions that must be considered in evaluating the building. Since this research project is focused on educational facilities in the Southeast United States, the comparison of rating systems will be based on these same criteria.

Building Rating Systems Application

The first phase of the research involved looking at different rating systems and how they consider LCA in their criteria. Since many of the building rating systems are adopted from other nations, the selection of rating systems for this research was directed to programs that were unique with regards to how much information they required and what detail of results were provided. With the exception of LEED, these rating systems all include some aspect of a carbon emission in the determination of the environmental impact of the facility. Review of the building rating systems to determine best practices can establish the groundwork of what methods are being employed and provide indication of what improvements can be made. This research provides the basis for the development of the computer based model that can readily identify the carbon foot-print for a new facility in addition to highlighting other potential ecological impacts.

Using the rating scorecards for the BREEAM, LEED, CASBEE, Green Star, Green Globes, and DGNB systems, a comparison was conducted to determine the similarities and differences in elements being evaluated. Samples of the scorecards are provided in Appendixes B through G. Figure 3-1 provides a summary of this information. For Figure 3-1, the bars reflect the percentage of points that the applicable rating system attributes to the specified category.

Table 3-1 provides information on the differences in how the rating systems evaluate the buildings. The chart includes information on the labelling of the certification in addition to percentage of points necessary in order to acquire that rating.

Table 3-1. Building rating system certification levels

BREEAM		LEED		CASBEE		Green Globes		Green Star		DGNB	
Pass	30	Certified	36	C	< .5	One Globe	35	1 – 3 Star	Not certif.	Bronze	50
Good	45	Silver	45	B-	.5	Two Globes	55	4 Star	45	Silver	65
Very Good	55	Gold	54	B+	1	Three Globes	79	5 Star	60	Gold	80
Excellent	70	Platinum	73	A	1.5	Four Globes	85	6 Star	75		
Outstanding	85			S	3						

LEED percentage based on LEED 2009 version 3.0
CASBEE score is based on a ratio and thus a percentage does not apply
Green Star scores below 45% are not certified

Carbon Emissions Comparison

Although a comprehensive LCA can provide a wide variety of data relative to environmental impacts, most of the building rating systems researched just focused on the carbon emissions. Table 3-2 represents the various stages of a building life cycle that are covered by the researched rating systems in calculating the building carbon footprint. In looking at the variations in what information is requested in order to determine how this can be normalized to apply to a wider audience, it becomes apparent that a more comprehensive system that includes all the stages of the building life cycle is necessary. This combination of all applicable data should result in the best overall approximation of the carbon emissions for a facility. Without this kind of information, estimates of carbon used for claiming that a building is "carbon neutral" is merely "green washing" instead of providing meaningful indicators of the sustainability.

Table 3-2. Life cycle stages considered in carbon calculation

Phase	BREEAM	LEED	CASBEE	Green Globes	Green Star	DGNB
Construction	No	No	Concrete and Steel	Yes	No	Yes
Operation	Yes	No	Yes	No	Yes	Yes
Transportation	Yes	No	No	No	No	No
Demolition	No	No	No	Yes	No	Yes

Life Cycle Assessment Tool Development

Software Selection

One of the primary goals of an appropriate LCA model is that the data is easily viewable to determine the documentation that provided the inputs for the database. Another criteria is that the individual processes are easy to manipulate and add or delete functions without disrupting the remainder of the model. Lastly, it was desired to have a program that could accept user supplied data in an international format.

As there are hundreds of types of models available, the selection was refined based on the Society of Environmental Toxicology and Chemistry (SETAC) (Kotaji et al. 2003) recommendations on applicable programs. Rice et al (Rice, Clift & Burns 1997) performed one of the first analyses of the various computational tools available for LCA analysis. They examined 12 of the predominant programs and determined that the basic function was similar; but there were significant differences with regards to method, speed, flexibility, and available information. The GaBi software, developed by the University of Stuttgart, was considered to be one of the new programs available with much to offer for the user.

As mentioned earlier, the optimum sources for information will come from the EPA, and their recommendations for software include GaBi. The sources for data can come from GaBi but also from other available resources in which either a process is missing or more accurate data is available. Additional locations for carbon data can come from sites such as BRE and the Carbon Trust. Due to the amount of research and variability in data regarding carbon footprinting, an important element in using different data sources is to make sure that it is concurrent with the primary data source methodology. A quick validation check could involve finding similar elements from both data sources and ensuring they have equivalent values in addition to ensuring the methods for calculating data are based on like parameters.

Model Development

The GaBi model is based on a system of processes. The processes contain the particular data relative to a specific operation such as environmental, social, or economic impacts. Thus by linking the construction process with flows of material or data, a simulation of the actual procedures can be created. Then by performing a balance of the data, the GaBi model will provide results that depict the aggregate of the applicable processes and their associated impacts on resources and pollutants. Most of the predominant reporting standards are preloaded into the GaBi database and thus the user can select between such protocols as CML, EDIP,EI99, and TRACI. This facilitates the analysis process by allowing the user to provide results consistent with the appropriate protocol and change between systems as may be necessary for reporting requirements.

One of the primary deficiencies for most LCA programs is the lack of detailed information for particular processes. In many cases it was noted that GaBi data would not be available for U.S. systems although there would be information for a European equivalent of the program. Since the primary processes are essentially equivalent, it was determined to be acceptable to use the European system and updates of the model could easily be performed by substituting U.S. processes as they become available. After all, the differences between using a product line in Europe instead of US are relatively insignificant compared to the option of not using the product line at all.

One of the advantages of the GaBi program is the inclusion of Data Quality Indicators (DQIs). For each source of data concerning a life cycle process, the data is labeled as either Calculated, Estimated, Measured, or Literature. In cases where data is available from a range of values, the user is able to specify the maximum and minimum values and a level of confidence can be established based on the results. These factors thus establish the level of reliability for the results of the life cycle analysis. If for example the majority of the data is from estimated sources instead of calculated and measured, it would indicate that the results are not as reliable and depict where the weakness exist in the input values.

The GaBi program was designed in Stuttgart, Germany and thus the majority of the data is reported in the International System (SI) of units. Since most of the construction measurements in the United States are done in the Imperial System or American Customary Units, conversion of the data between these systems is required. In order to facilitate the use of the model, the conversion of units is done within the model so that normal U.S. units are expected as inputs.

The remainder of this paper will distinguish between the generic GaBi program and the model developed to enhance the rating system. As the model developed for this research is intended to be used for the life cycle assessment process to determine carbon footprinting for building rating systems, it will be abbreviated as the LCABRS (Life Cycle Assessment for Building Rating System) model.

Building Life Cycle Phases

The GaBi tool was used to develop plans for each of the primary phases of the life cycle process within the LCABRS model. This allows the user of the model to analyze the entire life cycle or just focus on solely the manufacturing, construction, operation, or demolition phase. The results of each of these phases can be reported separately or combined for an overall performance of the building. Figure 3-2 depicts the basic life cycle process and the realization of how information will be captured to measure carbon emissions. Figure 3-3 is the primary module used in the LCABRS module. The manufacturing process has been combined within the construction phase to provide a more streamlined model. Since the information in the operation phase is independent of the construction phase, they were modeled in parallel processes. This permits the phases to be analyzed separately and thus makes the model very useful for situations in which only the operation phase of a building needs to be evaluated; thereby precluding performing a material take-off for every model simulation.

Based on the overall model, formula (3-1) was developed to calculate the life cycle carbon emissions from the building.

$$LC_c = CP_c + OP_c + DP_c \tag{3-1}$$

Where:
LC_c is the Building Life Cycle Carbon Emissions in CO_2 equiv.
CP_c is the construction phase Carbon Emissions in CO_2 equiv.
OP_c is the operation phase Carbon Emissions in CO_2 equiv.
DP_c is the deconstruction phase Carbon Emissions in CO_2 equiv.

The model has been designed to allow easy entry of values in the field called "global parameters". The field is set up so that the user has one location for checking the values used for multipliers, reference values, and project specific quantities. Based on the CSI Masterformat divisions, the global parameters are set up in files with similar headings to permit easy location of where applicable data can be modified. Table 3-3 depicts the information from the general criteria of the model. Prior to running the model, the user will be required to input values for each of these parameters.

Table 3-3. General reference values for building life lycle

Parameter	Comment
FTE	Full Time Employees
FTE_days_work	FTE works per year
Students	Average number of students
Student_days_school	student school days per year
Sq_m_bldg_area	Building area in square meters
Years_of_use	Life expectancy of building in years

Construction Phase

In the construction phase, the primary materials from each of the CSI Master-format divisions are used. This allows the user to directly input data from the building material take-off or by using material lists from Building Information Modeling (BIM) software.

A full life cycle normally begins with the manufacturing of the materials. The GaBi database has previously performed the analysis on the materials from the time of extraction through to purchase for building construction. The data files include documentation that went into the development of the constituents that are attributed to each manufacturing process. In most cases, the materials in the GaBi database are normally estimated based on the assumption that 1 kg of the item will be required. For example, in concrete the standard unit of processing is 1 kg and the data file will include all the quantities of chemicals that are produced or consumed in order to make the 1 kg of concrete. The GaBi model has been set up such that user will specify the total quantity of a particular product and then the model will automatically apply this factor to all of the constituents within the individual processes. Table 3-4 represents the weight factors that were used to convert from Imperial units that are standard for construction materials to metric kilograms. The International Code Council (Carson 1989)) provided data regarding the typical mass of building materials. In instances where a range of values was available, an average weight would be selected to compensate for the fact that construction normally has a wide range of material sizes. This method can dramatically simplify the calculation process without significantly degrading the overall quality of the data. If however, the building does not have the wide range of sizes, then the weight factor can be adjusted in the “Global Parameter” field to the appropriate value and the calculations will reflect the new information.

Table 3-4. Weight factors used for building construction

Parameter	Value	Comment
mass_concrete	1404	kg per cubic meter of concrete
mass_steel	823	kg per tonne of steel
mass_block	22.08	kg per CMU block
mass_brick	1.225	kg per brick
mass_copper_sheet	0.053	kg per square meter of copper sheet
mass_steeldeck	0.074	kg per square meter of steel deck
mass_bf_wood	0.93	kg per board meter of lumber
mass_osb	0.074	kg per square meter of OSB sheathing
mass_sheathing	0.074	kg per square meter of plywood
weight_al_sheets	0.013	kg per square meter of aluminum sheets
weight_coppersheets	0.053	kg per square meter of copper sheets
weight_fiberglass	0.002	kg per square meter of fiberglass insul.
weight_roofinsul	0.232	kg per square meter of roofings insul.
Weight_framing	0.691	kg per linear meter of al window frame
Weight_glass	0.136	kg per square meter of window glass
Weight_carpet	0.063	kg per square meter of carpet
Weight_paint	0.0001	kg per square meter of paint

Figure 3-4 depicts the processes contained within the construction process of the LCABRS model. The individual CSI divisions are also flow process used to replicate the manufacturing process. A sample of one of the manufacturing processes is shown for concrete in figure 3-5. All of the remaining process diagrams are contained within Appendix H

Based on the construction process model, formula (3-2) was developed to calculate the carbon emissions.

$$CP_c = [\sum_{q=1}^{m}(CC_q \cdot CM_q)+CT] + [\sum_{q=1}^{m}(MC_q \cdot MM_q)+MT] + [\sum_{q=1}^{m}(SC_q \cdot SM_q)+ST] + [\sum_{q=1}^{m}(WC_q \cdot WM_q)+WT] + [\sum_{q=1}^{m}(TC_q \cdot TM_q)+TT] + [\sum_{q=1}^{m}(OC_q \cdot OM_q)+OT] + [\sum_{q=1}^{m}(FC_q \cdot FM_q)+FT] \quad (3\text{-}2)$$

Where:

CPc is the construction phase Carbon Emissions in CO_2 equiv.
CCq is the CSI div.3 process material quantity
CMq is the CSI div.3 multiplier for Carbon Emissions in CO_2 equiv.
CT is the CO_2 equiv. from transporting the CSI div.3 materials to site
MCq is the CSI div.4 process material quantity
MMq is the CSI div.4 multiplier for Carbon Emissions in CO_2 equiv.
MT is the CO_2 equiv. from transporting the CSI div.4 materials to site
SCq is the CSI div.5 process material quantity
SMq is the CSI div.5 multiplier for Carbon Emissions in CO_2 equiv.
ST is the CO_2 equiv. from transporting the CSI div.5 materials to site
WCq is the CSI div.6 process material quantity
WMq is the CSI div.6 multiplier for Carbon Emissions in CO2 equiv.
WT is the CO_2 equiv. from transporting the CSI div.6 materials to site
TCq is the CSI div.7 process material quantity
TMq is the CSI div.7 multiplier for Carbon Emissions in CO_2 equiv.
TT is the CO_2 equiv. from transporting the CSI div.7 materials to site
OCq is the CSI div.8 process material quantity
OMq is the CSI div.8 multiplier for Carbon Emissions in CO_2 equiv.
OT is the CO_2 equiv. from transporting the CSI div.8 materials to site
FCq is the CSI div.9 process material quantity
FMq is the CSI div.9 multiplier for Carbon Emissions in CO_2 equiv.
FT is the CO_2 equiv. from transporting the CSI div.9 materials to site
m is the number of materials in a CSI division

At present there is very limited information available on the energy and pollutant emissions during the actual building construction process. Thus, the construction process of this LCABRS model ends up being primarily a combination of the manufacturing processes based on the required quantities for construction. However, the LCABRS model has been designed to account for the transportation requirements to get the material from the resale facility to the construction site. The model user has the option of inputting specific distances relative to material transportation in order to have more accurate analysis.

Operation Phase

The operation phase contains factors for annual usage of routine utilities and maintenance. From the BREEAM rating system, factors were included to account for transportation and potable water usage. From the Green Globes rating system, factors were added to account for material durability and maintenance requirements. Additionally, factors were included from the rating scorecards that assist in determining the effects of actions that sequester carbon such as vegetation and the purchase of Renewable Energy Credits (RECs). With the inclusion of both carbon emission and carbon sequestering factors, the model should be able to facilitate calculations to help determine if a facility is carbon neutral. After all, if a building claims to have a net zero affect, the rating tool should be able to demonstrate that capacity.

For the estimated life time emissions calculations, the annual operation resources are multiplied by the life expectancy of the building. Performing the calculations in this manner allows individual analysis of the impact on a particular year for changes in any of the operation processes. After performing a full life cycle analysis it is useful to divide the final number by the life expectancy in order to determine an estimated annual emissions rate. However, if there are significant changes in operation resources during the life of the facility, they can be accommodated by exporting the results to an Excel type of spreadsheet to permit summation of individual annual results.

Figure 3-6 represents the major processes that are contained within the Operation phase of the LCABRS model. More detailed models for the individual processes of utilities, and transportation are shown if figures 3-7 and 3-8 respectively. Appendix H contains all of the process diagrams from the LCABRS model.

Formula (3-3) was developed to estimate the lifetime carbon emissions from the Operation phase.

$$OP_c = \sum_{i=1}^{n}\left(\sum_{l=1}^{p}(UO_c) + \sum_{l=1}^{p}(MO_c) + \sum_{l=1}^{p}(TO_c) - \sum_{l=1}^{p}(VO_c) - \sum_{l=1}^{p}(RO_c)\right) \quad (3\text{-}3)$$

Where:
OPc is the operation phase Carbon Emissions in CO2 equiv.
i is the number of years
l is the number of subcategories
n is the life expectancy of the building
p is the quantity of subcategories
UOc is the Utilities Process Carbon Emissions in CO2 equiv.
MOc is the Maintenance Process Carbon Emissions in CO2 equiv.
TOc is the Transportation Process Carbon Emissions in CO2 equiv.
VOc is the Vegetation Process Carbon Emissions in CO2 equiv.
ROc is the Renewable Credits Carbon Emissions in CO2 equiv.

Utilities. All of the rating tools included points on their scorecards based upon energy reductions. With the exception of the Athena program, all other carbon calculation tools from the rating systems also included energy as a primary factor in determining the carbon footprint. Although the current LCABRS model was designed specifically with the Rinker and Gerson buildings in mind and thus only includes factors relevant to these building; the model has the capability to expand and allow a wide range of utility processes to be included in the analysis. For simplified calculations, the standard emissions were used from the LCABRS model for the United States. If more detailed results would be needed, the values within the specific processes could be adjusted to the reported emissions levels to accommodate the exact location.

Renewable. Most of the building rating systems provide points on their scorecards the purchase of Renewable Energy Credits (RECs). The LCABRS model has been designed to permit the user to input values relative to the amount of renewable energy being produced or RECs that have been purchased. Since there is a tremendous amount of diversity relative to the carbon emissions that are being offset by these sources, it is up to the user of the model to get the information concerning the quantity of CO_2 equiv. that have been diverted and input that value directly into the model. If required, the model can be adjusted to account for pollutants and resources other than carbon provided the user adjust the process parameter for this item in the LCABRS model.

Transportation. In utilizing the carbon techniques of the BREEAM program, the LCABRS model has been designed to include the impacts of vehicle traffic associated with the building. The transportation is based on average sized unleaded fuel type vehicles. These factors can be changed within the model processes if a different country or transportation scenario is specified. The factors that were used to determine percentage of occupants that drive and distance traveled are derived from a University of Florida transportation report for average quantities around the campus.

Maintenance. Rating tools such as Green Globes included points for the durability of materials and planning for future maintenance. Additionally, the BREEAM rating system included routine maintenance as part of the transportation calculations for carbon emissions. Thereby, the LCABRS model was designed to include a maintenance factor that is primarily concerned with vehicle transportation of maintenance staff plus a factor to account for materials that could be used in normal maintenance operations. The model can be readily adjusted for specific situations in order to assist in determining the environmental impact and for detailed analysis that will assist in calculating the durability of specific products.

Vegetation. Derived from the site category of the various rating systems, the vegetation factor has been added to include the sequestering factor from plants. An important factor in calculating the carbon reductions is to reduce the value by the appropriate amount of carbon emissions and soil contaminants that may result from mowing and fertilizing. The reference value for lawns used by this model does not include any lawn care or maintenance; but this can be adjusted based on the users requirements. Additionally, the tree sequestering factor was based on average values and should be adjusted based on different tree types and sizes.

Table 3-5 provides a list of the reference values that were used in the operation phase. These values are considered relatively constant for the buildings located in similar conditions as the researched facilities.

Table 3-5. Reference values used for building operation

Parameter	Value	Comment
CO_2_per_lawn	0.048	kg CO_2 sequestered per square meter
CO_2_per_tree	112.6	kg CO_2 sequestered per year per tree
FTE_kms	8	Average kilometers to work for FTE each way per day
Student_kms	6	Average kilometers to school for student each way per day
Service_call_distance	6	Kilometers driven for maintenance call each way

Deconstruction Phase

In the deconstruction phase of the model, factors are included to account for material reuse or recycling. Additionally a space is provided to calculate the carbon emissions due to waste water handling. Unless otherwise specified, the waste is assumed to end at the landfill and the environmental impact is determined based on the inputs from the construction and operation stages. Therefore, the weight of material going to landfill is based on the weight of the construction materials minus the weights of materials going to incinerator or recycle/reuse. Since there is a wide variety of carbon impacts from the various reuse/recycling options, it is up to the model user to input the specific carbon savings in CO_2 equiv. due to the technique being used. If the user desires to model the impact from pollutants other than carbon, then the process flows within the LCABRS model will also need to be adjusted accordingly. In order to facilitate the calculation of the waste emissions that are being diverted, the user has the option of taking the values from the construction process LCA and inputting the values into the parameters for the waste.

Figure 3-9 depicts the processes that are part of the deconstruction phase. As the individual process are simply calculations relative to the quantities specified, there are no subsequent figures for the individual processes.

Formula (3-4) was developed to calculate the carbon emissions from the Deconstruction process.

$$DP_c = ((CC_q + MC_q + SC_q + WC_q + TC_q + OC_q + FC_q - IW_q - RW_q) \cdot CW_c + IW_c \cdot IW_q - RW_c \cdot RW_q) \qquad (3\text{-}4)$$

Where:
DPc is the deconstruction phase Carbon Emissions in CO_2 equiv.
CCq is the concrete process material quantity
MCq is the masonry process material quantity
SCq is the steel process material quantity
WCq is the wood process material quantity
TCq is the thermal process material quantity
OCq is the opening process material quantity
FCq is the finishes process material quantity
CWc is the construction waste multiplier for Carbon Emissions in CO_2 equiv.
RWc is the recycled waste multiplier for Carbon Emissions in CO_2 equiv.
RWq is the recycle waste quantity
IWc is the incinerator waste multiplier for Carbon Emissions in CO_2 equiv.
IWq is the incinerator waste quantity

Model Capabilities

The LCABRS model includes numerous functions that perform detailed analysis of the data. The user has the option to analyze individual process or the entire LCA to evaluate the impact of changing single or multiple parameters. A sensitivity analysis can be performed to determine what inputs have the greatest effect and likewise which has the least impact. Additionally, the scenario that was used for this analysis was based on the TRACI Global Warming standards as defined by the EPA. A user has the option of selecting a full range of ecological triggers to determine the overall environmental impact of the construction.

Some of the benefits of the GaBi tool include the ability to categorize the processes and emissions. A model user has the ability to specify a parameter such as material location, specific pollutants, or other user developed parameters. This lets the analysis be very specialized and the results can be honed into the exact needs of the researcher.

Other tools in the GaBi program permit the user to perform Monte Carlo distribution analysis of the materials. Additionally, due to the ability to adjust parameters over a range of values, the model is able to perform detailed scenario analysis to determine the ideal scenario of components. With the variety of diagrams available to choose from, the user can find graphic tools to meet most research needs.

Method for Using the Life Cycle Assessment for Building Rating Systems Model to Reduce Carbon

Unfortunately, the LCABRS model in itself is not sufficient to automatically inform the user what factors need to be adjusted and by how much these factors need to be altered in order to improve the sustainable performance. By implementing the following methodology, the user would be capable of taking advantage of a life cycle assessment process implemented with the LCABRS model to determine a building environmental impact and then make decisions concerning alternatives for material and process choices.

Perform Life Cycle Assessment

The first step is to establish the boundaries for the life cycle assessment. As part of the procedure, it is necessary to develop a flow diagram of the process. In building construction, this can be broken into four primary phases: manufacturing, construction, operation, and demolition. From this flow diagram, all the inputs and outputs from the system can be captured and used to establish the parameters to be analyzed. For a typical building the boundaries can be set based on the building site and what utility lines are connected to the main feeders. Since the building owner will have little influence on the utility distribution components, these materials would not be included in the analysis.

The next step is to develop a data collection plan. During this phase, the various materials that are used during the building construction and operation are identified. This requires a detailed analysis of everything that is required for that specific project plus an approximation of all the materials that are used during the life cycle of the building assuming normal wear and tear on the materials. The last part of this plan is to look at the disposal options available and anticipate how the material will be treated after the building has been demolished. To accomplish this task, a data collection worksheet and checklist should be developed. Critical to this step is to stay within the boundaries identified in the previous step and within a particular timeline. By using the worksheet, it is possible to identify the appropriate components and the source of their data.

Step three of the process is to actually collect the data for each of the materials in their particular phases. The International Standards Organization (ISO) has established procedures to address the wide variety of methods available for collecting LCA data. By following the protocols of ISO 14041 (International Organization for Standardization 2006a), many of the problems of conflicting data should be avoided.

The final step is to analyze the data provided by the LCABRS model. This can be done by putting the data into a tabular format and looking for any discrepancies and statistical significance. The data should reflect the information gathered from within the boundaries established in the first step and demonstrate the variances between the four phases of the building life cycle.

Evaluate Phases

In this step the data can be normalized based on life expectancy and building area in order to make assumptions concerning the values that are significantly greater than other process and make comparison to other buildings. At this phase, other LCIA information provided by the LCABRS model can be examined to determine if there are significant elements other than carbon. Based on the life cycle analysis, one of the phases is selected for additional analysis to determine what can be done to improve the performance of the life cycle.

Primary Factors

At this point, the phase that was selected for evaluation is examined in greater detail to determine which process can afford variation and have a significant impact on the environmental quality. Ideally a process should be selected where changes can be made in accordance with a variation of parameters. A realistic understanding of the limitations of the construction process is critical to save time and preclude examining processes that cannot be altered to meet the desired effect.

Adjust Parameters

Using the scenario variation function of the LCABRS model, the process that was selected for analysis is established as the variable in which the parameters are permitted to change from a maximum to a minimum value. The balance program in the GaBi tool allows the program to run from the minimum parameter value to the maximum value and plots the variation of the carbon emissions.

In some cases, as one parameter changes, it may have a direct impact on a different parameter. In those scenarios, it may require that more than one parameter is adjusted at a time in order to gain an indication of the realistic results from adjusting the values.

Based on the parameters range, a balance is performed on the particular phase to determine what parameter values have the most optimum result. The parameters are then chosen for incorporation back into the full life cycle model.

Recalculation and Analysis

The full model is analyzed with the new values to confirm that a better performance has been realized. At this time it is a good idea to look at the other environmental indicators to see if the improvement in carbon emissions may have resulted in a deficiency in another ecological sector.

Repeat

If there are still indicators that the overall performance has not been optimized, then the process is repeated again by looking at a different phase and/or processes.

The evolution is continually repeated until the building performance has obtained the desired results.

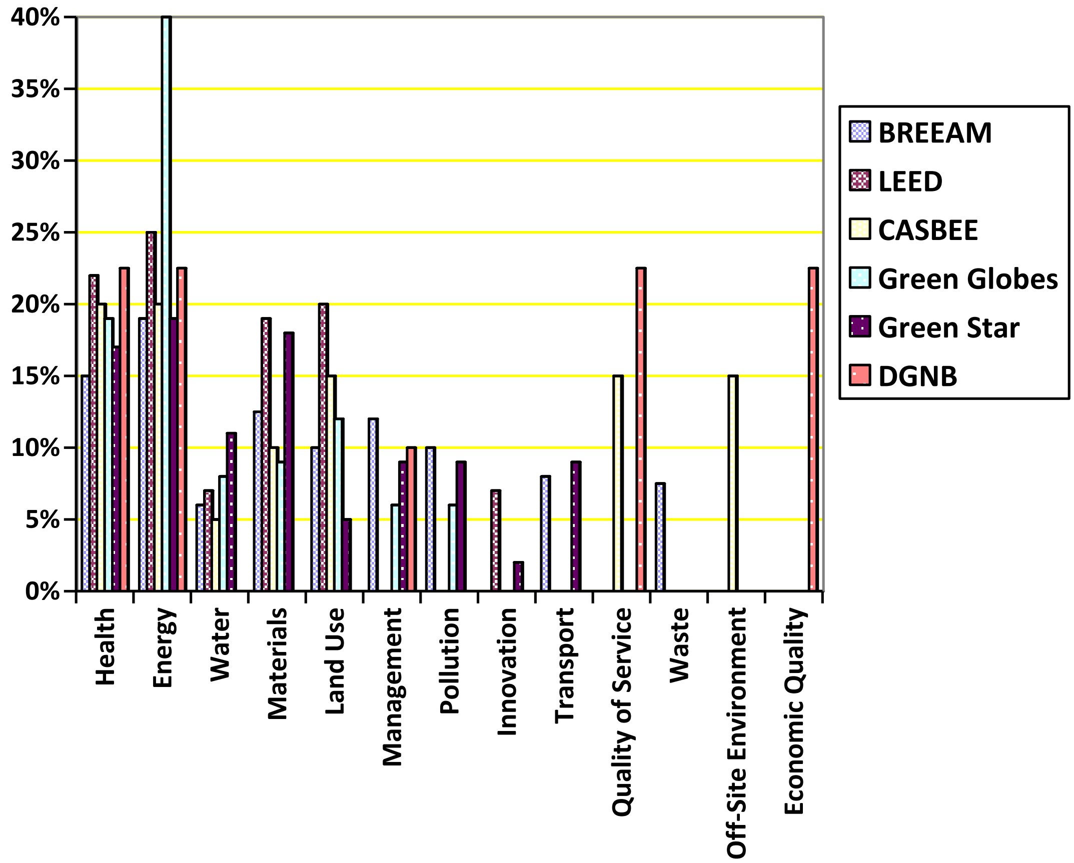


Figure 3-1. Categories based on percentage of total points per rating system

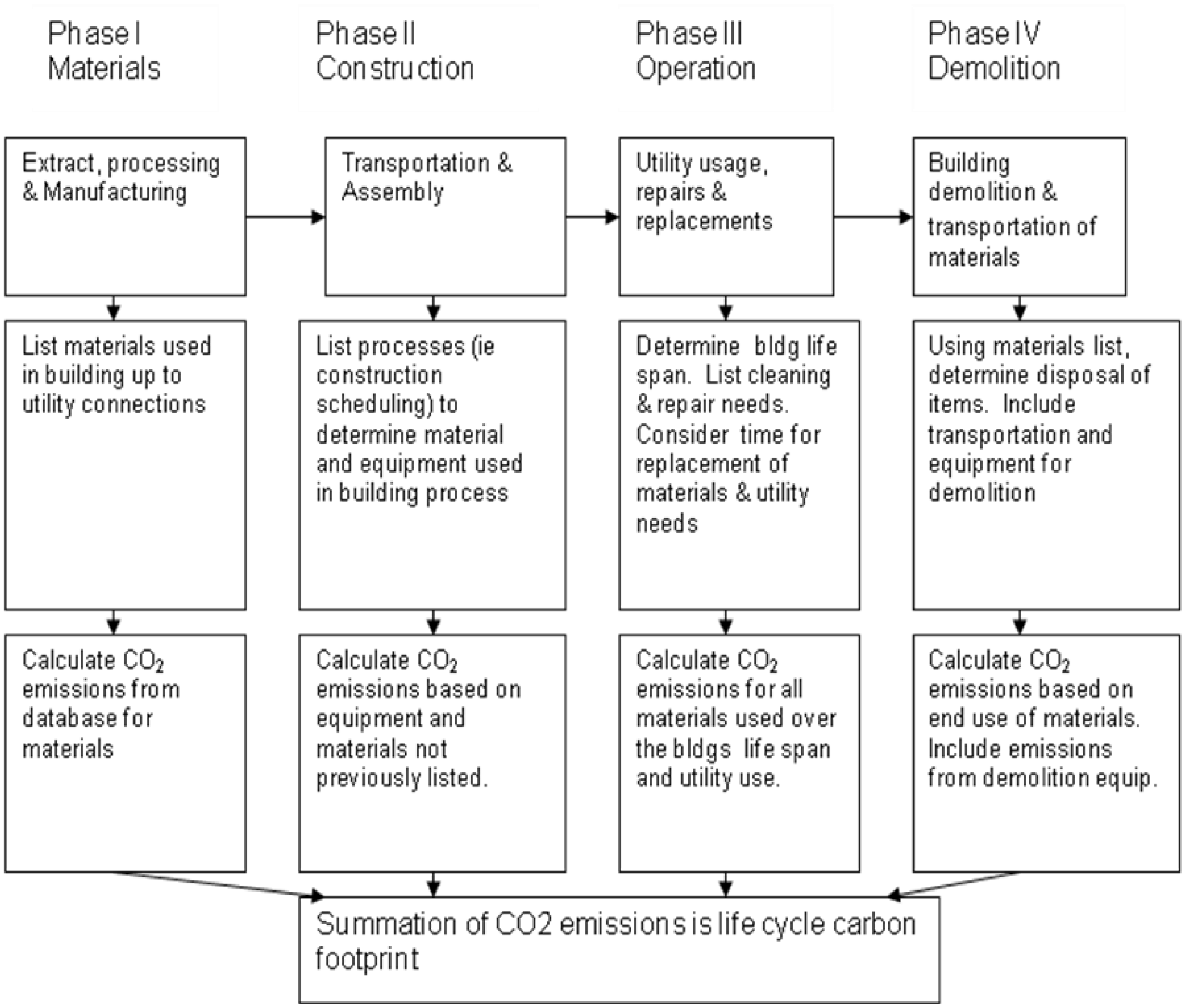


Figure 3-2. Building life cycle carbon emissions process

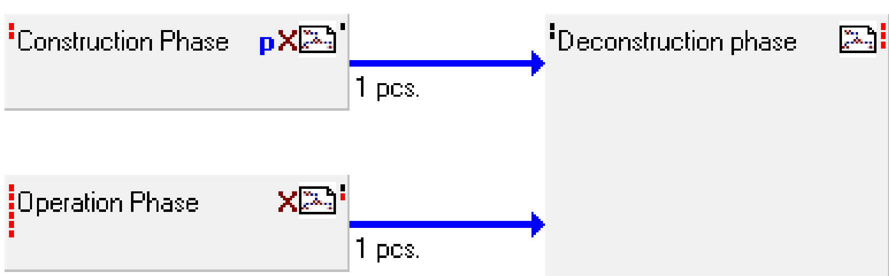


Figure 3-3. Building life cycle flow for Life Cycle Assessment for Building Rating System (LCABRS) model

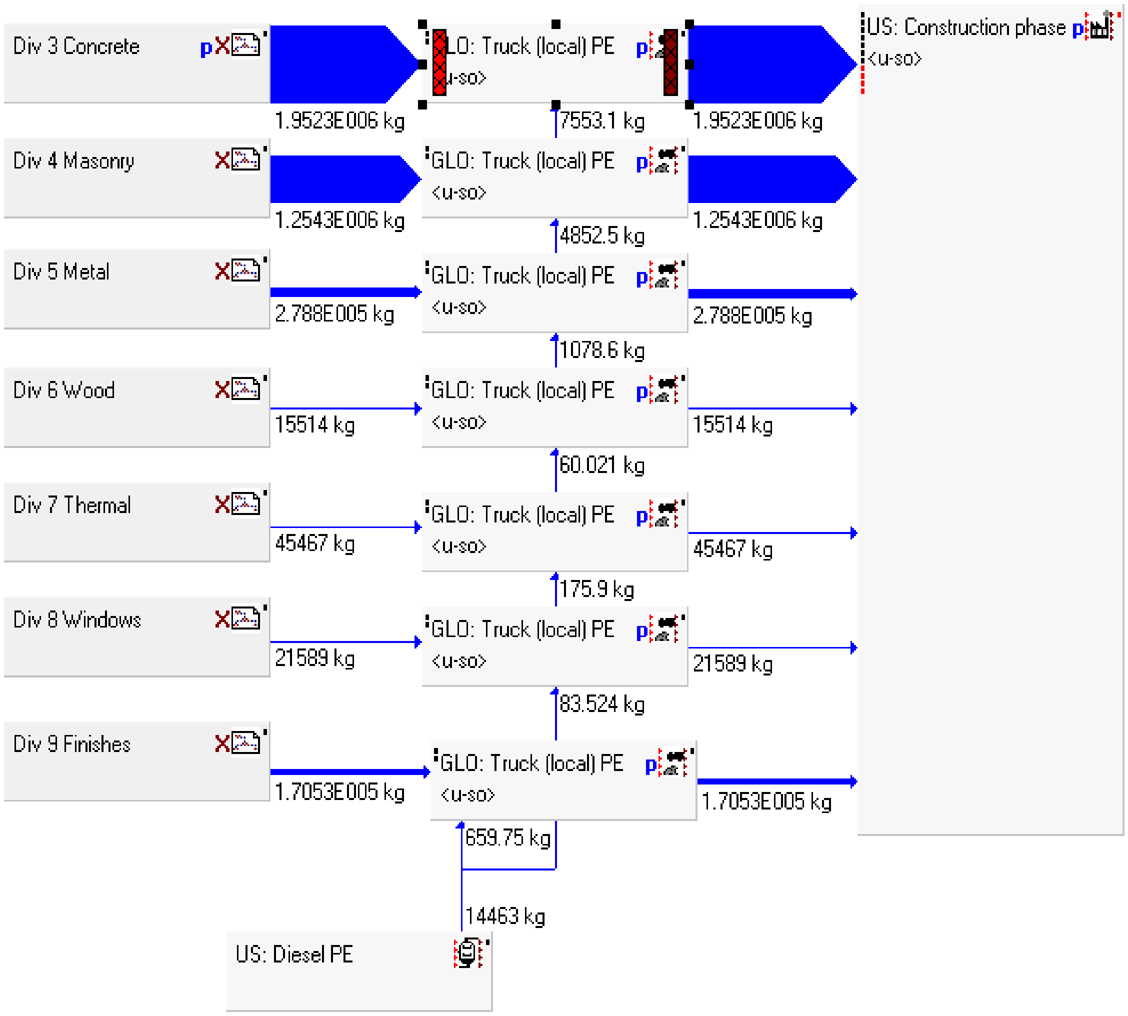


Figure 3-4. Construction flow from LCABRS model

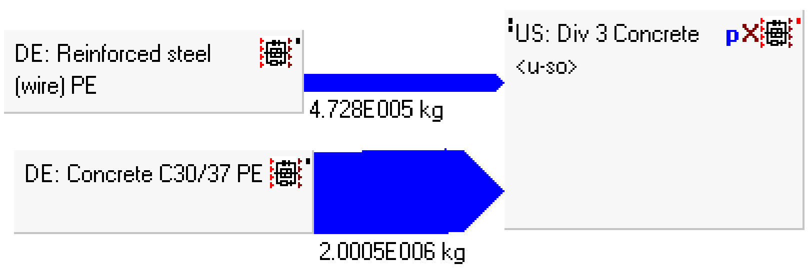


Figure 3-5. Concrete flow

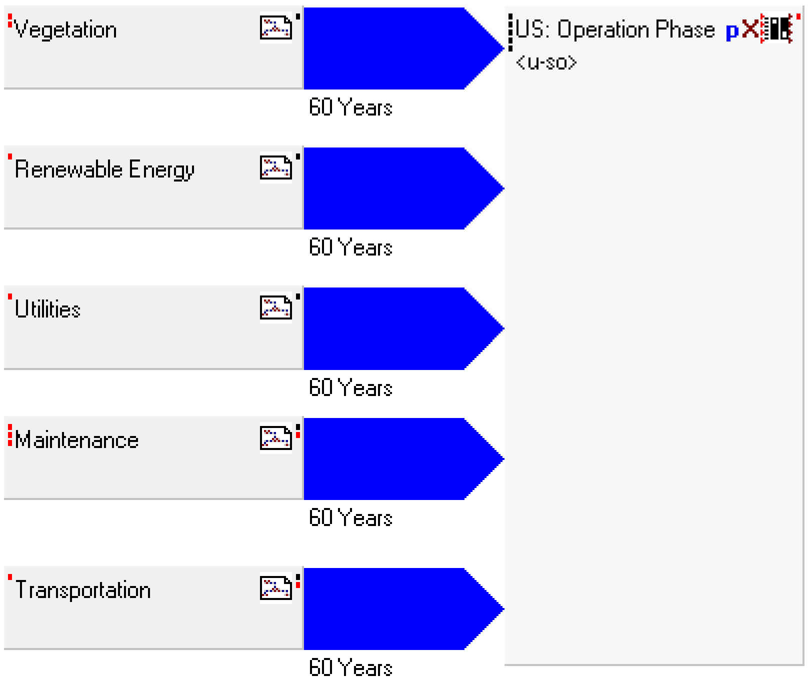


Figure 3-6. Operation flow from LCABRS model

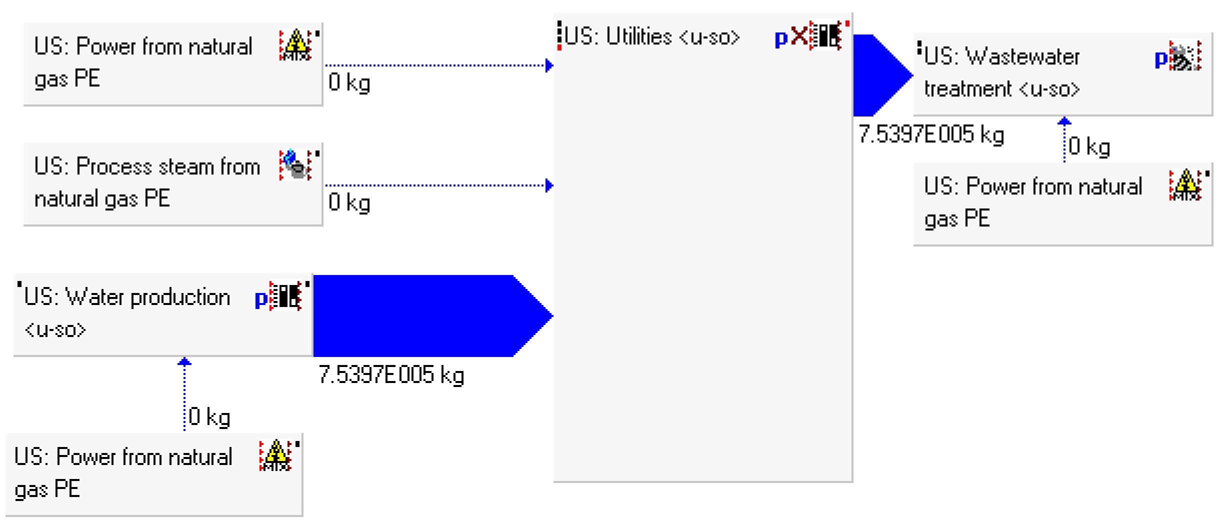


Figure 3-7. Utilities process

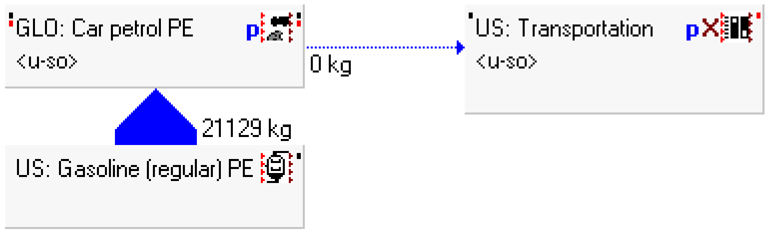


Figure 3-8. Transportation process

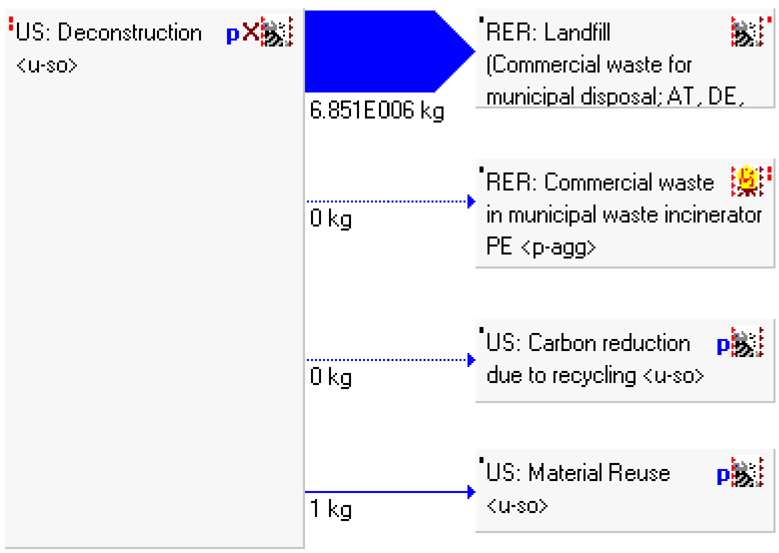


Figure 3-9. Deconstruction flow from LCABRS model

CHAPTER 4
RESULTS

In order to determine if a method can be developed that demonstrates a correlation between building rating systems and carbon footprint calculations to assess sustainability, it is first necessary to examine how a set of buildings compare when rated by the other rating systems. By comparing two buildings, one that has a sustainable rating and the other that doesn't, it can be demonstrated the differences in how the rating systems evaluate the buildings and essentially establish a benchmark for a non-sustainable building LCA. The LCABRS model will then be used to evaluate the two buildings and calculate the carbon emissions. The results of this analysis will be compared with the carbon calculations from the other rating systems and a validation of the data will be conducted. Next the results will be compared with the actual performance data for the sustainable rated building to examine any variations in how the facility classification could have changed. Finally, a case study will then be used to demonstrate the new tool and how it can assist in the reduction of a buildings footprint in either the design or operational phases.

Facility Selection

In the comparison of a sustainable rated and a non-sustainable rated building, it is best to select facilities that are in a similar climate, have the same function, are based on the same regulatory authority, and were constructed at the same time. In 2003, the University of Florida did not require that all new construction facilities would be built to a LEED standard. It was up to the individual building occupants to determine if funding would be authorized in order to construct a facility to a sustainable standard. Thus selecting two facilities constructed on the campus at that time would be able to meet the criteria established for an unbiased comparison as long as the facilities had similar functions.

For a sustainable building, the M.E. Rinker School of Building Construction was chosen. This was the first building in the state of Florida to be certified to a Gold level through the LEED rating system version 2.0. The facility is a 4,322 square meter, three story structure that is primarily used for classrooms and faculty offices. Primary construction is steel frame with glazing and aluminum panel curtain wall. Approximately 450 students use the facility on a daily basis during the school year. Final occupancy occurred in January 2004.

The Gerson Hall Accounting building was selected as the facility that had not been designed or constructed with the consideration of a sustainable rating system. This 3,683 square meter, three story building serves as the classroom facility for 350 students and offices for 25 faculty. Primary construction is CMU block with a brick façade. The facility was completed in 2004.

Table 4-1 provides a quick summary of the differences between the two buildings that were used for the development of the carbon rating methodology.

Table 4-1. Building specifics

	Rinker Hall	Gerson Hall
LEED	Gold	N/A
Year	2003	2003
Square meters	4,322	3,683
Purpose	Education	Education

Boundary Conditions

One of the first steps in collecting data for a LCA is to establish the boundaries of the system being measured. Being that the facilities are located on a university campus, there is not a direct relation between the property boundaries and the project boundaries. However, the drawings for the construction work included landscape improvements to a limited distance from the new building and likewise this same area was chosen for the boundaries of the LCA. Since the utilities are provided by a central distribution system, the allocation of utilities was taken directly from the metered facility connections. For operational considerations, any relevant items or individuals that crossed the property boundaries were included in the building inventory. Finally, in keeping with the university policy to assume a life expectancy of 60 years for new facilities, the same time was used in the life cycle assessment.

Material Take-offs

As part of this process, a material take-off was performed on the buildings to determine the inventory list of construction materials. The material take-offs of the two buildings originated from the construction drawings and specifications. These documents provided all the data relative to the site boundary and the construction materials. Although contractor estimates were available for the Rinker building, they were only used as a validation of the material take-offs. This was determined to be the most effective means to keep the collection of information consistent for the two buildings, since there was no data available from the contractors of the Gerson building. Normally contractor estimates include a factor for waste material due to excess required to compensate for discrepancies, unknown conditions, and installation variations. Since the waste factor applied is not consistent between contractors and across all trades consistently, it was determined to not include this factor for the inventory (Dagostino, Peterson 2011).

Since the normal procedure for conducting material take-offs in the United States is to request that subcontractors provide quantities based on the Construction

Specification Institute (CSI) Masterformat, the data was organized in a similar manner. For projects in the United States or sponsored by US government entities, the Masterformat is also the preferred manner of organizing construction materials. Therefore, the data for the research buildings was also organized into accordance with the CSI Masterformat divisions. Appendix A provides the results of the material take-offs for Rinker and Gerson.

Although complete material take-off estimates were developed for the two buildings and is included in Appendix A, it was determined to use only the most prominent items as part of the analysis. In addition to dramatically simplifying the data entry process, this is also in compliance with ISO 14041 (International Organization for Standardization 2006b) recommendations to only analyze data that can be considered relevant based on a percentage of the overall mass, energy, or environmental relevance. For this research a threshold value of 5% was established to preclude inclusion of materials that had no significant impact on the final results. Table 4-2 provides a comparison of the most predominant materials for both Rinker and Gerson in accordance with the applicable CSI divisions. Since there is no significant LCA information on CSI divisions 10 through 16, they have been omitted at this time.

Table 4-2. Building material summary

CSI Divisions	Description	Units	Rinker	Gerson
Division 3 Concrete	Concrete Reinforcement	Cy Tons	1407 56	1089 9.3
Division 4 Masonry	CMU Block Brick	Ea Ea	4709 56544	27688 153087
Division 5 Metal	Steel members Decks	Tons Sf	265 48000	150 45000

Table 4-2 continued

CSI Divisions	Description	Units	Rinker	Gerson
Division 6	Blocking	Bf	4614	6915
Wood	Sheathing	Sf	14029	15061
Division 7	Membrane	Sf	17300	4844
Thermal	Roof	Sf	16300	504
	Al panels			
Division 8	Doors	Sf	2187	3373
Doors & Windows	Glazing	Sf	10929	5054
Division 9	GWB	Sf	140967	68142
Finishes	Carpet	Sf	1667	22616

Utilities

The University of Florida Physical Property Division (PPD) maintains records of energy, water, and maintenance requirements for all campus facilities. The most accurate and recent year of reports was from 2008 and thus this was chosen as the benchmark for considering the utilities usage. An evaluation on the utility usage of the two buildings was performed as a masters' thesis by Catherine Simeon (Siemon 2009) and served as validation for the collected data. Additionally, an analysis of the potable water system was conducted by John Dryden as part of his Doctoral Dissertation (Dryden 2006) and demonstrated that at the University of Florida, potable water production requires 3.1 kWh of electricity for every 1000 gallons. Also, the processing of wastewater at UF requires 15.2 kWh of power.

Figures 4-1 through 4-4 depict the recorded utility usage based on electricity, steam, chilled water, and potable water. Additionally, figure 4-5 demonstrates the total energy usage based on the combination of kWh for the electricity, steam, and chilled water.

Transportation

Personal interviews were conducted with building managers to determine the normal operating times and occupancy for the buildings. Based on the number of full time employees and students, the campus transportation report (STAR) (Sims 2011) was used to determine the estimated kilometers that are driven by occupants. The report estimated that about 70% of the faculty drive cars and about 17% of the students drive. It is also estimated that the average faculty distance per day is 30 kilometers, while the student distance is 6 kilometers.

For Rinker Hall, there are an estimated 27 staff and 450 students. Gerson has an estimated 25 faculty and 350 faculty. The faculty drive to school approximately 250 days per year and students drive 225 days. Based on these assumptions, Rinker would have a total of 262,864.6 kilometers driven per year and Gerson would have 226,968.1 kilometers. With an average vehicle gas consumption of 8.5 km per liter, this would convert to 30,870.6 litres of gas for Rinker and 26,654 litres for Gerson.

Additionally, based on the maintenance service calls record provided by PPD, it can be estimated that Rinker had 275 service calls and Gerson had 309 service calls per year. If each service call resulted in a round trip of 13 kilometers from the PPD building to the respective research facility, this would account for an additional 278 litres of gas for Rinker and 313 litres for Gerson on an annual basis.

Recycling

At the time of construction, the planned end of life for the materials when the building is being deconstructed is to end in the landfill. However, the Rinker building received innovation points on its LEED scorecard for incorporating elements to permit it to be deconstructed in such a manner to facilitate reclaiming all of the steel for recycling. Therefore, the total mass of material for Rinker that was being landfilled was reduced by the mass of the steel and a respective amount of recycled material was added to the LCA calculation. For the Gerson building, since no actions were taken during the design phase to allow for improved recycling capabilities, it is assumed that all material would end in the landfill.

Landscape

The construction drawings were used to determine what plants, shrubs, and sod were used on the construction sites. A very detailed list of plants was provided for the Rinker building and is included as part of their material take-off in Appendix A.

The Gerson building did not include landscape elements and therefore, no calculations were performed for the building.

For the trees and shrubs, a spreadsheet was developed based on Department of Energy's "Method for Calculating Carbon Sequestration by Trees in Urban and Suburban Settings" (Voluntary reporting of greenhouse gases 1998). The spreadsheet used values from the DOE's guide relative to whether the trees are classified as fast, medium, or slow growing. Additionally, the trees are specified by the type as being either hardwood or conifer. Factors such as the age of the tree and the life expectancy of the plant were included in the calculations to provide a more specific indication of the anticipated annual carbon sequestration. Based on the calculations, the trees at Rinker would sequester approximately 2.85 tons CO_2 eq. per year.

For the lawn, a direct multiplier was used based on the University of Florida research (Hostetler, Escobedo 2010) on carbon sequestering from lawns in Florida. The table provided by the UF research was very specific based on regions, performance of maintenance, and whether the area had trees in addition to the lawn coverage. Based on the calculations, the lawn could sequester 1.25 tons CO_2 eq. per year. Combining the effect of the trees and lawn would account to a sequestering of 4.115 tons CO_2 eq. per year.

Rating Systems Comparison of Facilities

Since the Rinker building received its LEED certification based on design criteria, in order to provide an equitable comparison of the building rating systems, the Rinker building properties were based on the design phase energy model and construction drawings. Since there was no energy modeling conducted on the Gerson building, the actual conditions were used for the analysis of the rating systems. The following sections provide a summary of the results noticed when evaluating these buildings based on the applicable method.

Building Research Establishment Environmental Assessment Method

Appendix B contains the simulated results of the Building Research Establishment Environmental Assessment Method (BREEAM) score card for both the Rinker and Gerson Buildings. A required part of the rating system is a calculation of the carbon emissions. Carbon calculations are based on utilities including water, business transportation, staff commuting travel, and greenhouse gas emissions. As this method adds the impact of transportation, an obvious increase in operational carbon emissions is noticed. For the Rinker building, by using the Carbon Calculation tools, it was estimated that the annual carbon emissions from the building would be 376.88 tonnes CO_2 per year or an equivalent of 87.2 kg CO_2eq /m^2-yr. The simulated analysis of the BREEAM program indicated a rating 67.51% and a score of Very Good. The Gerson building had an estimated Carbon emission of 446.7 tonnes CO_2 per year or normalized to 121.3 kg CO_2eq /m^2-yr. The simulated BREEAM score was 27.35% and not considered to pass the minimum requirements for certification

Leadership in Energy and Environmental Design

Appendix C contains the score card for Rinker and a simulated score card for the Gerson buildings. The Rinker building earned a Gold level of certification from version 2.0 of the Leadership in Energy and Environmental Design (LEED) rating system for New Construction. Significant highlights for the project included modeled energy and water savings of 50% each. The facility earned 39 out of a possible 69 points. Using the LEED v2.0 scorecard, Gerson Hall was analyzed to determine the possible number of points it could have earned. Based upon university construction regulations at the time, the building would have earned 3 points with a possible 14 other points depending on construction practices. The maximum points possible would have been17, which is 9 points short of the required 26 points for LEED certification. Although there is currently a pilot program for conducting LCAs that can earn one point for Innovation, there is no requirement that any formal LCA or Carbon calculation must be followed to earn LEED certification.

Comprehensive Assessment System for Building Environmental Efficiency

Appendix D contains the simulated data from the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) scorecards for both Rinker and Gerson. Carbon calculation is a required factor to complete the rating system. Information from either energy usage or from an energy model is needed to determine the carbon footprint. The carbon footprint calculation also includes a small section in which the amount of concrete, steel, and timber used in the structure is factored into the overall carbon equation. Using the computer based energy model for Rinker building would potentially be ranked with a value of 2.0 and have an assessment grade of “A”. Based on the life cycle CO_2 the building would save 44% from a standard building. The results indicated an annual carbon emission per square meter in kg CO_2eq of 10.24 for construction, 16.68 for repair/demolition, and 26.55 for operation. This provided an annual emission of 53.47 kg CO_2eq per square meter. A simulation of Gerson Hall demonstrated a grade of “B-” with a score of 0.7. The annual carbon emission was estimated to be 17% higher than the standard required for similar Japanese buildings. The results indicated an annual carbon emission per square meter in kg CO_2eq of 10.24 for construction, 16.68 for repair/demolition, and 84.45 for operation. This provided an annual emission of 111.37 kg CO_2eq per square meter.

Green Star

Appendix E has the simulated Green Star score card for the Rinker and Gerson buildings. A portion of the rating system requires the calculation of the carbon emissions based on the predicted operation phase by means of energy modeling as compared to anticipated demands of the facility. A simulated analysis of the Rinker building indicated that the facility would earn 53 of a possible 141 points for a potential score of 4 Green Stars. Based on the energy modeling, the program estimated the facility would have an annual carbon emission of 211,734 kg CO_2eq or 49 kg CO_2eq /m^2-yr. Using the actual energy demands and construction practices for the Gerson building estimated that the facility could possible earn 2 Green Stars due to scoring 26 out of a possible 141 points. The energy demands estimated an annual carbon emission of 421,932 kg CO_2eq or 114.5 kg CO_2eq /m^2-yr.

Green Globes

Appendix F has the simulated Green Globes score card for the Rinker and Gerson buildings. Green Globes has a specific category relative to LCA in which up to 35 points can be earned by using programs such as Athena's Ecocalculator. The Athena program is based on the Uniformat division of construction materials and uses the square feet of building systems to calculate the ecological impacts. The results are based on manufacturing, construction, and demolition; but do not include factors for operational and energy demands. During the simulated analysis the Rinker building could earn 567 of 931 possible points for 61% of the total. This would qualify the building for a certification of 2 out of a possible 4 Green Globes. By using the Athena EcoCalculator program the carbon footprint for the building was estimated as 1824 tonnes CO_2eq. Gerson Hall may qualify for 213 of 931 possible points for 23% of the total. Since a minimum of 35% of the points must be earned in order to receive certification, the building would not receive Green Globes certification. Using the building data in the Athena EcoCalculator demonstrated that the building would have a carbon footprint of 1422 tonnes CO_2eq.

Deutsche Gesellschaft fur Nachhaltiges Bauen

Appendix G has the simulated Deutsche Gesellschaft fur Nachhaltiges Bauen (DGNB) scorecard for the Rinker and Gerson buildings. The system is based on a questionnaire that includes a very detailed analysis of the building systems in accordance with the Uniformat system and the energy demands. The LCA components are calculated using a new GaBi model called "Build-it". Using the Build-It program, the carbon emissions from the Rinker building were estimated to be 55 kg CO_2eq /m^2-yr per year based on actual energy usage. For the Gerson building, the estimated carbon emissions were 74.7 kg CO_2eq /m^2-yr.

Figure 4-6 provides a summary of the results from the various rating systems applied to the buildings and demonstrates the similarities of the results.

Life Cycle Assessment Tool Application

After establishing that the Rinker building and Gerson building are evaluated in similar manners by the various rating systems, the information from these facilities can be used in the developed LCABRS model. The following information provides the details used in establishing the LCA tool and subsequent carbon calculations. This information is provided in conjunction with the LCA Tool Development section from the Methodology section of this report.

Building Life Cycle Phases

The information from the personal interviews and review of building drawings and specifications was used to establish these parameters. Table 4-3 depicts the information from the general criteria of the model.

Table 4-3. General reference values for building life cycle

Parameter	Rinker	Gerson	Comment
FTE	27	25	Full Time Employees
FTE_days_work	250	250	FTE works per year
Students	450	350	Average number of students
Student_days_school	200	200	student school days per year
Sq_m_bldg_area	4322	3683	Building area in square meters
Years_of_use	60	60	Life expectancy of building in years

Construction Phase

The material take-off information was condensed to provide the inputs for the construction phase of the LCABRS model. Table 4-4 represents the quantities of materials used during construction that are specific to the building being designed.

Table 4-4. Values input specifically for the buildings being analyzed.

Parameter	Rinker	Gerson	Comment
cm_concrete	1076	833	Quantity of concrete in building
Tonnes_rebar	12	8	Quantity of rebar in metric tonnes
Block_quantity	56544	27688	Number of CMU blocks
Brick_quantity	4709	153087	Number of bricks
Sm_steeldeck	4459	4181	Square meters of steel decking
Tonnes_steel	250	136	Metric tonnes of steel members
Bf_wood	4614	6915	Board feet of dimensional lumber
Sm_sheathing	1303	1399	Square meters of plywood
Sm_al_sheets	1514	230	Square meters of aluminum sheets

Table 4-4 continued

Parameter	Rinker	Gerson	Comment
Sm_roofinsul	1607	450	Square meters of roof insulation
Window_area	1	1	Square meters area of window
Window-perimeter	9	9	Linear meters of window perimeter
Qty_Al_window	236	256	Quantity of Aluminum windows
Coats_of_paint	2	2	Coats of paint on wall surfaces
Sm_carpet	155	2101	Square meters of carpeting
Sm_GWB	13096	6331	Square meters of GWB
Sm_to_paint	13096	6331	Square meters to be painted

Operation Phase

Table 4-5 provides specific data items pertinent to the particular conditions of each of the researched facilities. The values used for the Rinker building utilities are based on the energy model that was developed prior to construction. The values used for the Gerson building utilities are based on actual conditions.

Table 4-5. Specific values used for building operation analysis

Parameter	**Rinker**	**Gerson**	**Comment**
Lawn_coverage	3728	2408	Square meters of lawn

Tree_quantity	23	0	Number of hardwood trees
Maint_calls	275	309	Service calls per year
Chilled_water	76000	351951	kWh chilled water per year
Electricity	235000	455180	kWh of electricity per year
Potable_water	219800	248800	Gallons of water per year
Steam	112189	127328	kWh of steam per year
REC's purchased	0	0	REC's purchased in CO_2 equiv.
Percent_student_drivers	.17	.17	Percent of students that drive
Percent_FTE_drivers	.7	.7	Percent of FTE that drive own vehicle

Deconstruction Phase

Table 4-6 depicts the parameter variables that are available for alternatives to landfilling. The value for material going to the landfill was based on the inputs of material in the construction phase. If material needs to be considered above that specified during construction, it should be added as a separate quantity into this field. Additionally, the LCABRS model permits the inclusion of alternative techniques for waste diversion should the need arise.

Table 4-6. Specific values used for building deconstruction analysis

Parameter	Rinker	Gerson	Comment
Reuse	1.5E5	0	kg of material that will be reused
Recycle	0	0	kg of material that will be recycled
Incinerated	0	0	kg of material that will go to incinerator

Life Cycle Assessment Tool Validation

Before using the LCABRS model, it should be validated to demonstrate the results are in accordance with acceptable values. Since there are no other LCA models that have the rigor of the designed LCABRS model, a comparison needs to be made that starts by looking at the research buildings energy levels to determine if they are within an expected range. By using the CBECS results for average buildings energy demands bases on particular regions, a benchmark can be set for a non-sustainable building. Figure 4-7 represents the normal distribution of energy between services within an educational facility in the Southeast U.S. Therefore, the Gerson building should have an energy level that is similar to CBECS levels and establish that the Gerson building can be used as a benchmark for the LCA.

Based on the 2003 results from the CBECS, an educational facility in the southeast of the United States within the 25,000 to 50,000 square foot area (2,322 to 4,645 square meters), has an average combined energy use of 830 MWh. Based on the range of facility sizes this would provide an energy range per square meter of 0.36 kWh to 0.18 kWh and result in average value of 0.27 kWh per square meter.

The energy levels of Rinker were estimated to be 311 MWh and 3829 therms for a combined annual energy usage of 423 MWh or 0.098 kWh per sm. The actual measured energy levels for Rinker in 2008 were 986 MWh or 0.228 kWh per sm. Gerson reported an energy use of 934 MWh which would result in 0.254 kWh per sm. This information is depicted in figure 4-8. Although the energy levels of the planned Rinker building were significantly lower than the CBECS range, the readings for the actual buildings were well within the expected results of the CBECS

Next, a comparison is made between the carbon emissions of the other rating systems to that of the research facilities. Since the different rating systems look at different building life cycle phases, it is not expected that the total values will be in complete agreement. However, the particular building life cycle stages from the

LCABRS model should be similar to the calculated results from the respective rating systems life cycle phases.

To perform this analysis, the building data outlined above is used as the inputs for the LCABRS model. For validation of the LCABRS results, the energy model levels will be used in Rinker and the actual energy levels used in Gerson. Based on these parameters, the CO_2 equivalent calculations are 97.81 kg CO_2 per m^2/yr for Rinker and 204.47 kg CO_2 per m^2/yr for Gerson.

To best determine if the results are similar to the other rating systems, a statistical analysis using the Chi Square goodness of fit test was used to establish the probability of significance for the series being independent. The computer based program "Calculation for the Chi-Square Test" (Preacher 2001)was used to calculate the applicable values. Due to the disparity of calculating methods for the various rating systems, the data was grouped into two categories: construction phase and operation phase. In addition, all the data ranges were normalized based on the applicable size of the facility and anticipated time of building use. For the construction phase, the chi square analysis was conducted on the values obtained from Green Globes, CASBEE, DGNB, and LCABRS programs. The construction phase received a chi square value of .773 with 3 degrees of freedom and a probability value of .859. For the operation phase, the rating systems of BREEAM, CASBEE, Green Star, DGNB, and LCABRS were evaluated. The chi square value was calculated to be 3.311 with 4 degrees of freedom and a probability value of .5. Thereby it can be argued that the values are not independent and a correlation exists between the rating systems and the carbon calculations. Figures 4-9 and 4-10 graphically demonstrate the distribution of the calculated values for carbon emissions from the various rating systems in the construction and operation phases respectively. As this data reveals, the range of variables from the LCABRS model are well within the range calculated from other prominent rating systems and carbon calculators. Thereby, it would be reasonable to expect the results of the LCABRS model to provide valuable and reliable information.

Case Study

In order to best demonstrate the functionality of the new method involving the LCABRS model for LCA evaluation and carbon footprint calculation, an analysis will be performed based on actual building readings. To demonstrate the flexibility of the model, the case study will be evaluated in two simulated situations: prior to construction and then again using actual energy data from several years following building occupancy. This demonstration will show how the LCABRS program can be used to assist in decision making based on varying life cycle conditions.

Pre-construction Phase

To demonstrate the actual performance of the buildings, the data from PPD is used relative to energy and resource consumption.

Perform LCA. The same construction and operational data is used from the LCA Tool Application section of this report.

Evaluate phases. The Gerson building is used as benchmark to establish goals of which phases of the life cycle should be adjusted. Figure 4-11 indicates the life cycle phases of the Rinker and Gerson buildings under actual conditions.

From this chart it can be seen that the carbon emissions of the construction and deconstruction phase for the Rinker building are actually higher than the benchmark facility. Thus, it would be worthwhile to examine these parameters to determine if any revisions could be made that would improve their performance.

Since the deconstruction value is tied directly to the mass of material used in the construction phase, any reduction in the construction phase should result in a similar reduction in the deconstruction phases. Naturally, the other alternative would be to plan for an increased amount of recycled and reused waste to offset the higher values. Based on this evaluation, the construction phase will be evaluated for possibilities of further improvements.

Primary factors. Using the data from the material take-offs, it can be determined which of the construction materials has the largest deviation from the benchmark facility. Figure 4-12 depicts the percentage difference between the quantities of material in Rinker and Gerson. For a quick evaluation, only the most significant materials from each of the applicable CSI divisions was selected.

Figure 4-12 shows that finishes and thermal have the largest variation with other significant differences coming from masonry, metal, and concrete. Although, it still needs to be determined which of these elements will have the greatest impact on the overall carbon footprint.

The next analysis of the data can be conducted based on the percentage of the overall carbon emissions that particular construction materials contribute to the building. Figure 4-13 demonstrates the results from the LCABRS model in which it uses the carbon emissions data from the construction phase to determine percentage contribution of each process. As the figure shows, the largest percentage of the carbon emissions can be attributed to the Concrete manufacturing process. The next largest contributor is Metal with the third most significant material being Masonry.

By analyzing the two charts together the overall impact can be estimated and thus make the decision of which materials to evaluate easier to interpret. For example, although the Thermal process from Rinker contributes 75% more carbon emissions, figure 4-13 shows that the Thermal process is less than 3% of the overall carbon emissions. Thus changes in Thermal process are not going to be significant changes to the overall carbon emissions. Instead, the three main process to be evaluated would be Concrete, Metal, and Masonry.

Adjust parameters. In construction, if one material is diminished often another material will need to be used as an alternative. In the analysis of concrete, metal, and masonry it needs to be realized that there will likely be a minimum value of these elements that are required for the facility to be structurally sound. Although the actual analysis of construction techniques will require evaluation from a structural engineer, this is intended as a demonstration of the capabilities of the model to assist in the material selection.

From the GaBi database it can be calculated that concrete has 2108 kg of CO_2 equiv. for every cubic yard of material produced. For metals, the GaBi database calculates that 1872 kg of CO_2 equiv. are emitted for every ton of material produced. Since the concrete has a larger impact, for trial purposes, it will be determined what happens to the results by cutting the concrete quantity in half or using 703 cy of concrete. In addition, the rebar will be reduced from 13 tons to 6.5 tons. Figure 4-14 depicts the new distribution of percentages in the construction processes due to these variations.

Recalculation and analysis. Having found a combination of parameters that provides a more efficient carbon emission, the next step is to verify the complete life cycle once again. This time, in addition to looking at the carbon emissions, the other ecological impacts of the TRACI system will be reviewed. Figures 4-15 through 4-29 show the changes in the TRACI metrics due to adjusting the Rinker actual values to the quantities calculated for improved carbon emissions.

Repeat. If it is determined that any of the TRACI values or perhaps another parameter should be adjusted, then the process would begin again with the analysis of the LCABRS results to determine the process that has the greatest impact.

Post-construction Phase

The final step of the research involves a case study of Rinker Hall based upon the conditions that apply after construction combined with the actual measured energy requirements. The intent of the analysis is to show how the rating of the building has changed from planned levels, estimate the real carbon emissions, and then use the LCABRS model to recommend changes to improve performance

Perform LCA. The same project boundaries were used for this analysis as for the validation procedure for the LCABRS model. Additionally, there were no significant deviations from the construction documents that need to be factored into the updated model. The major variation between planned and actual conditions was in the energy use of the building. Using the PPD data from 2008, the chilled water was measured as 374,798 kWh, the steam 179,728 kWh, and the electricity 431,588 kWh.

Evaluate phases. The Gerson building was again used as benchmark to establish goals of which phases of the life cycle should be adjusted. Figure 4-30 indicates the life cycle phases of the two buildings under actual conditions.

The largest variation is naturally due to the operational phase. The differences in the construction phase are still the same as during the design phase; but would also require extensive resources to alter the materials after the building has been occupied. If any improvements in recycling options can be found after building occupancy, then they will only provide more of a benefit for the overall building carbon footprint.

Primary factors. Using the LCABRS model, it can be determined which of the operation processes are the largest contributors to the carbon emissions by performing a weak point analysis. Table 4-7 reflects how the LCABRS analysis depicts the factors and thus isolates recommended areas for further review:

Table 4-7. Tool for Reduction and Assessment of Chemical Impacts (TRACI) global warming from Life Cycle Assessment for Building Rating System (LCABRS) analysis

	Building LCA	Building LCA	Building LCA	Building LCA
		Operation Phase	Operation Phase Transportation	Operation Phase Utilities
Flows	41922078.08	34184296.74	5923652.936	38467153.35
Resources	-273573.646	-59324.5076	-3751.944055	-75272
Emissions to air	42195651.73	34243621.25	5927404.88	38391881.35

The transportation contributions can be reduced by encouraging alternatives to a single person driving a single vehicle to the building. Any reduction in the transportation category would have a direct reduction in the carbon emissions and improve the overall carbon footprint for the building.

The utilities contributors are pictured in Figure 4-31. It can be seen that the majority of energy demands are due to the electricity and chilled water. Most of this change can occur in the selection of the HVAC equipment; but a certain percentage of the contribution could be accredited to the insulation of the building envelope. Detailed energy modeling that examines the impact of the construction materials would need to be used in order to provide a better estimate for the results.

Another option would be to install a renewable energy source. One of the original design plans for the Rinker building included the installation of a 20kW photovoltaic array of panels. For demonstration purposes, it will be demonstrated the impact of changing the electricity use in the building.

Adjust parameters. As the installation of PV equipment would also provide a significant additional material resource, it is interesting to determine the impact on the overall building carbon emissions due to this alteration. Current technology in PV arrays indicate a life cycle carbon emission of 35 to 58 g CO_2 equiv./kWh (POST 2006). Unfortunately, there is inadequate information relating to actual life cycle assessments that include the full range of pollutants that are released due to PV production. None of the current LCIA data include adequate data for input into the LCABRS model and thus the impact must be simulated as an offset of carbon compared due to the reduction in normal electricity purchased. Based on the NREL PV calculator (NREL 2011), the 20kW system would produce 25,711 kWh of power per year. This would result in a carbon emission from the PV panel of 899 to 1,491kg CO_2 equiv. per year. However, the use of natural gas for electricity production creates a carbon emission of approximately .55 kg CO_2 equiv. per kWh. Therefore the 25,711 kWh of electricity from a natural gas source would emit 14,141 kg CO_2 equiv. Thus it can be estimated that using the planed quantity of PV panels would reduce carbon emissions by an average of 12,946 kg CO_2 per year. Although, since the total annual carbon emissions due to electricity from natural gas contributes 227,000 kg CO_2 equiv. per year, this will only account for a 5% reduction in carbon emissions from electricity production.

Recalculation and analysis. The next step is to examine the complete life cycle once again and determine if there has been a detrimental impact in another phase of the life cycle due to the modification. In the case of the PV panels there could be impacts in other environmental properties; but at this time there is insufficient data to make a valid determination. As more information becomes available on LCA processes, this will be a valuable step in determining the overall environmental impact due to applying high tech options that have significant pollutant capabilities.

Repeat. Similar to the pre-construction phase, if it is determined that the user desires to further reduce the selected property or another parameter creates a significant environmental impact, then the process is repeated until the desired outcome can be achieved.

Since the LCABRS model has been designed to have individual models for the construction, operation, and deconstruction phases; the program can provide very specific analysis of every aspect of the life cycle. The advantage to this type of open ended analysis is that it allows the user to update the model with improved data and continually update the ecological impacts.

Since the LCABRS model does not include any energy modeling techniques, it would be beneficial to rerun the energy model after any major change in the structural envelope. As there are some changes that could result in significant changes in the building energy demands, it would be beneficial to recognize those elements in the design stage and compensate for them appropriately.

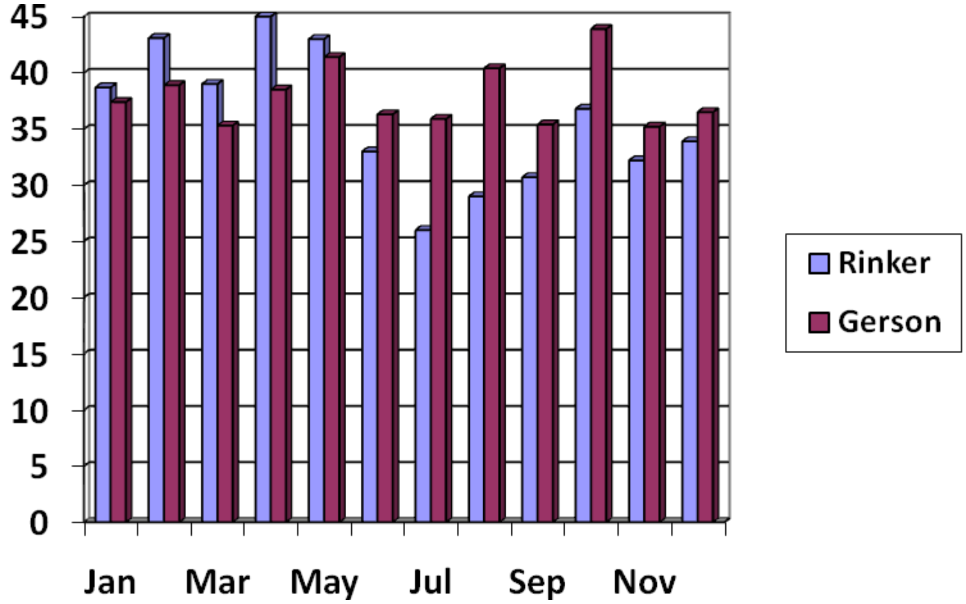


Figure 4-1. 2008 electricity use in MWh/month

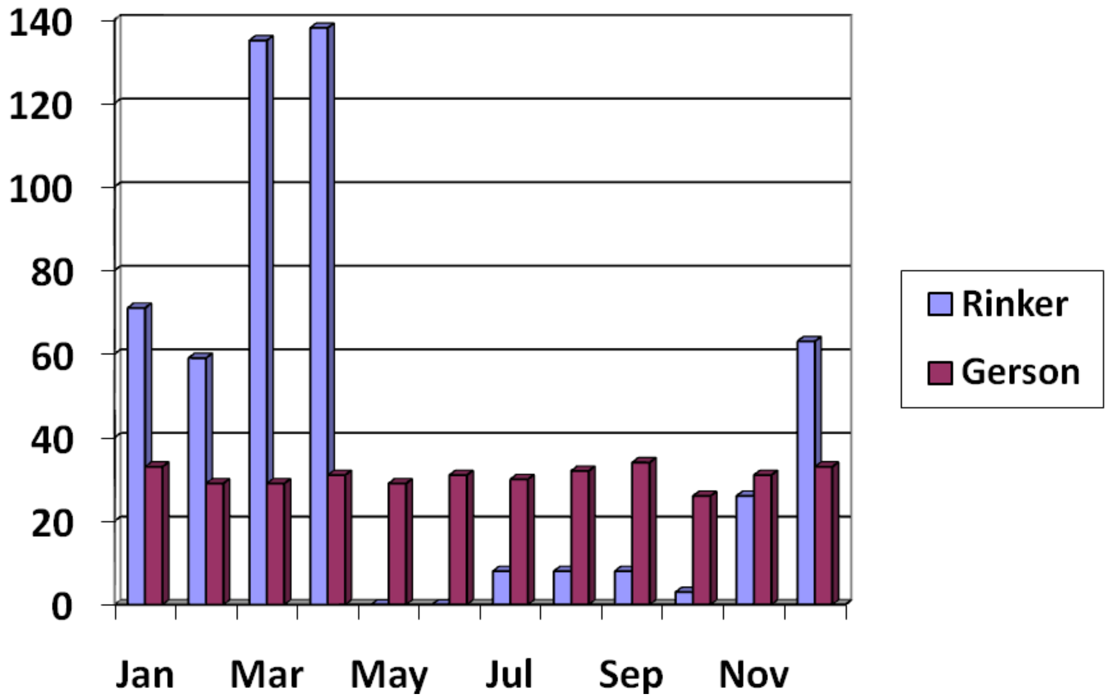


Figure 4-2. 2008 steam use in klbs/month

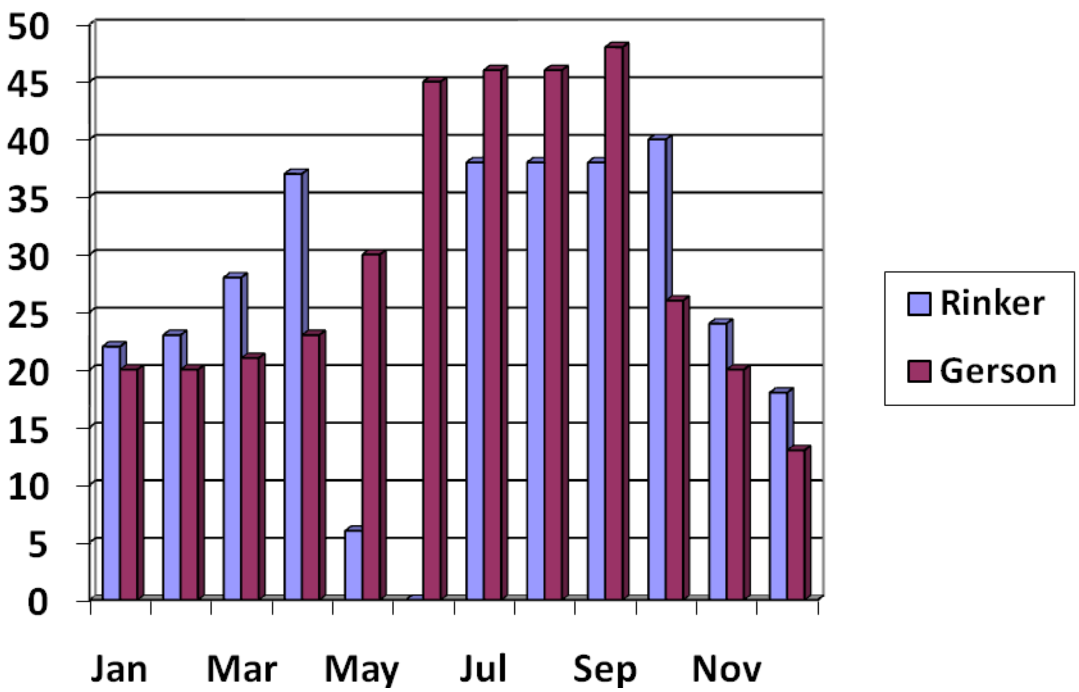


Figure 4-3. 2008 chilled water use in kton-hrs/month

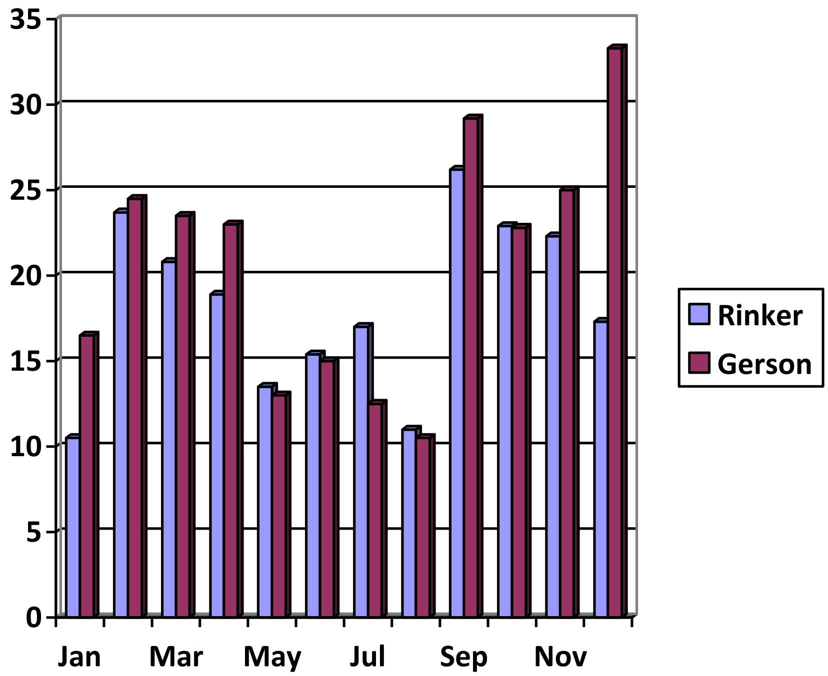


Figure 4-4. 2010 potable water use in kgal/month

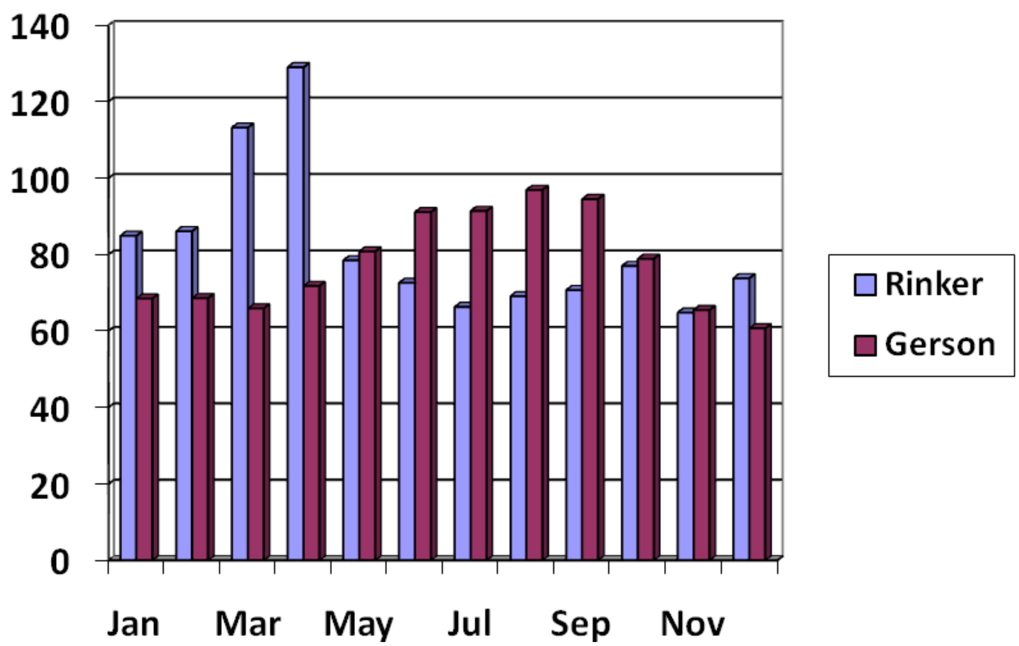


Figure 4-5. 2008 energy use in MWh/month

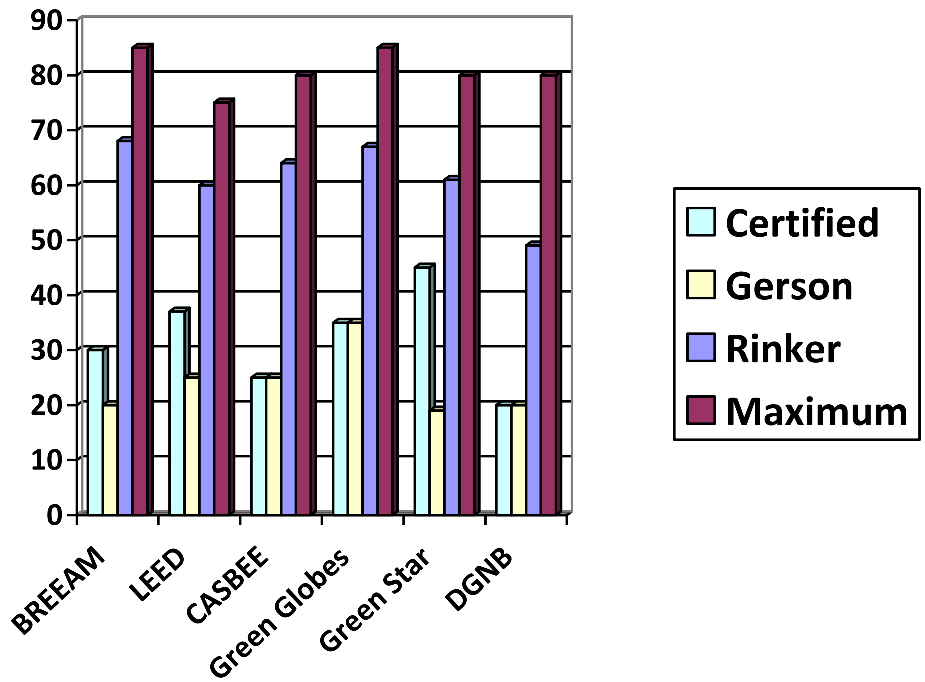


Figure 4-6. Comparison of rating systems levels and how they evaluated the research buildings

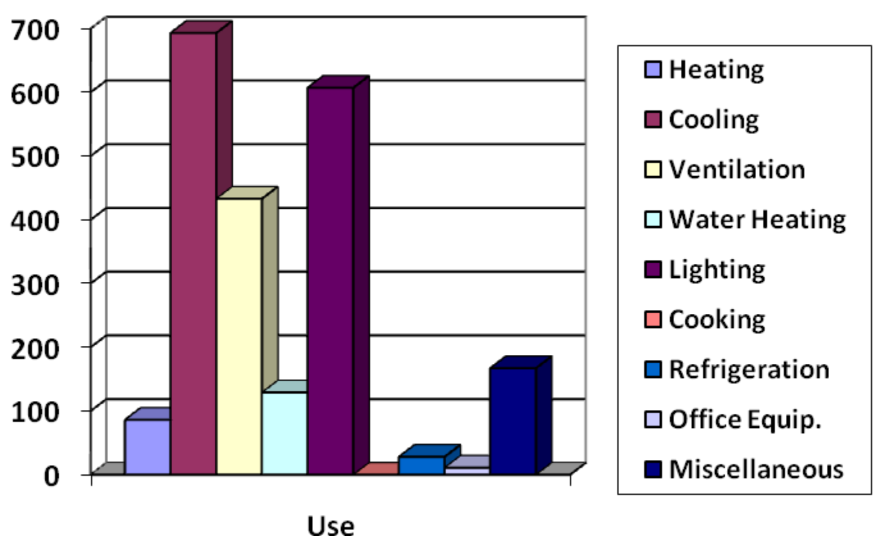


Figure 4-7. Commercial Building Energy Consumption Survey (CBECS) average electricity usage in educational facilities

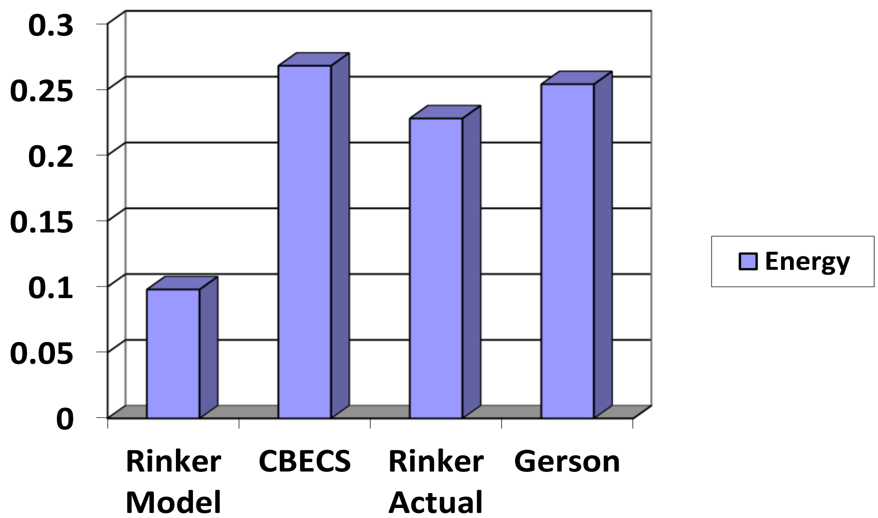


Figure 4-8. Comparison of energy levels in kWh per sm/yr

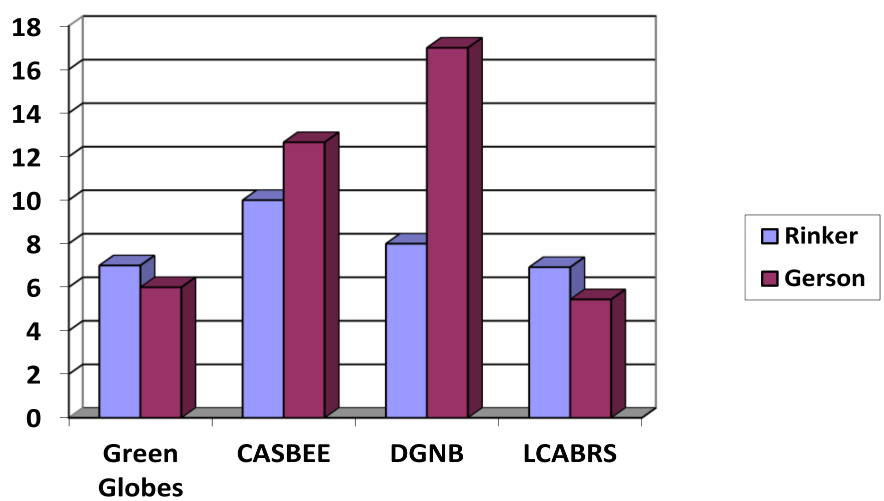


Figure 4-9. Building rating tools carbon analysis of construction phase kg CO_2 equiv. per m^2/yr

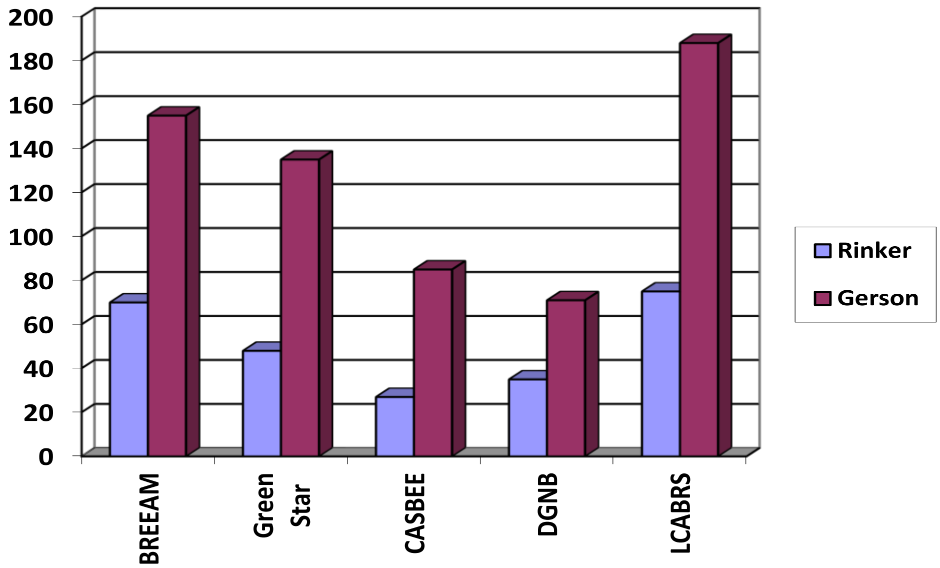


Figure 4-10. Building rating tools carbon analysis of operation phase kg CO_2 equiv. per m^2/yr

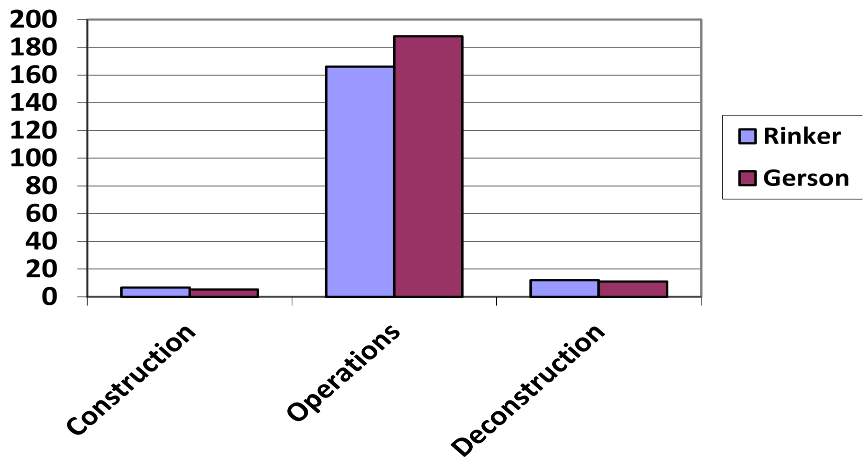


Figure 4-11. Comparison of calculated life cycle phases carbon in kg CO_2 equiv./m^2/yr

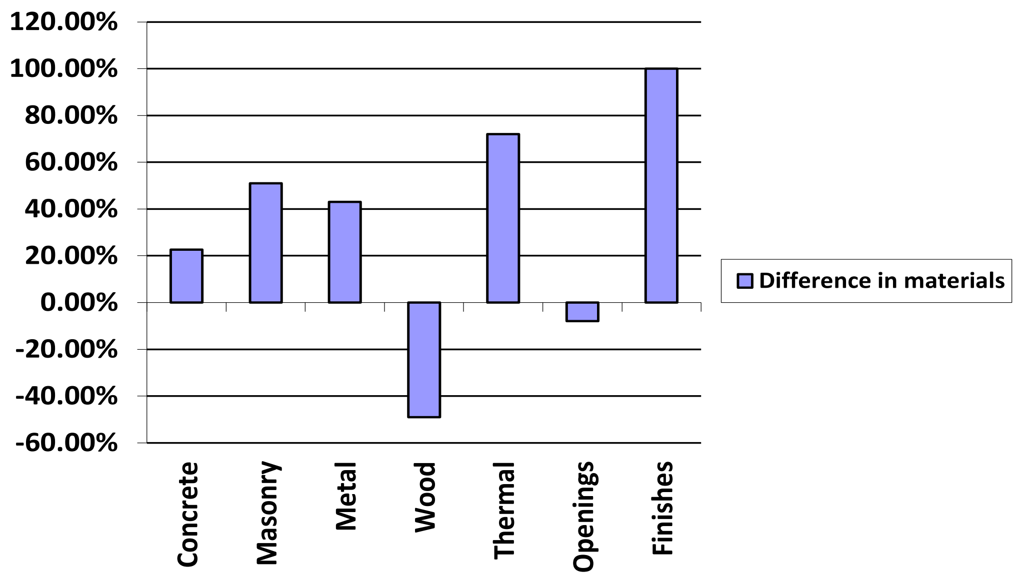


Figure 4-12. Variation in material quantities between Gerson and Rinker in which positive indicates Rinker is larger and negative is Gerson is larger

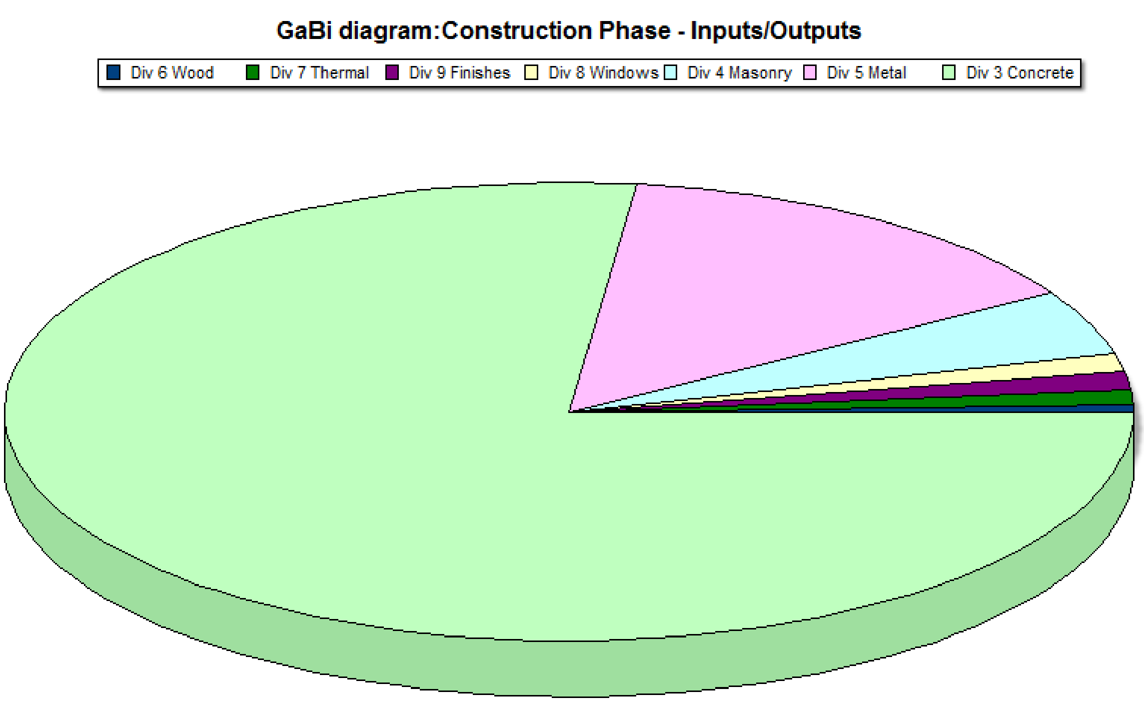


Figure 4-13. Percentage of total carbon emissions in construction phase by Construction Specification Institute (CSI) divisions

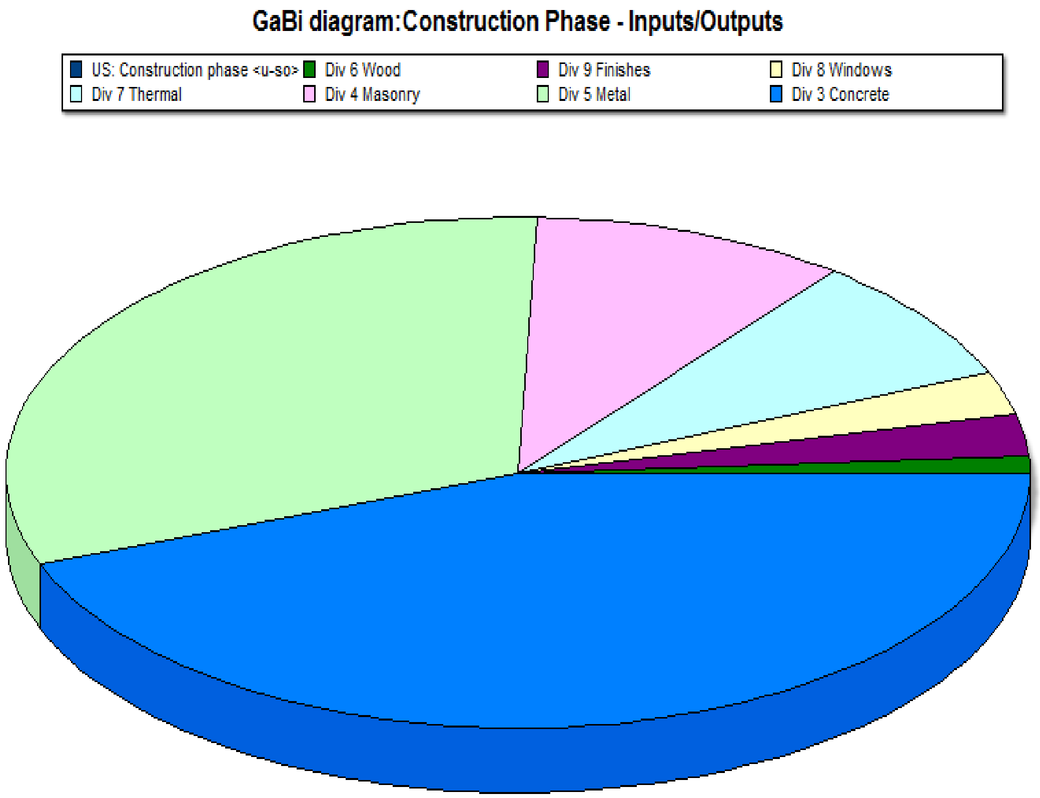


Figure 4-14. Percentage of total carbon emissions in construction phase from recommended change of 50% reduction in concrete

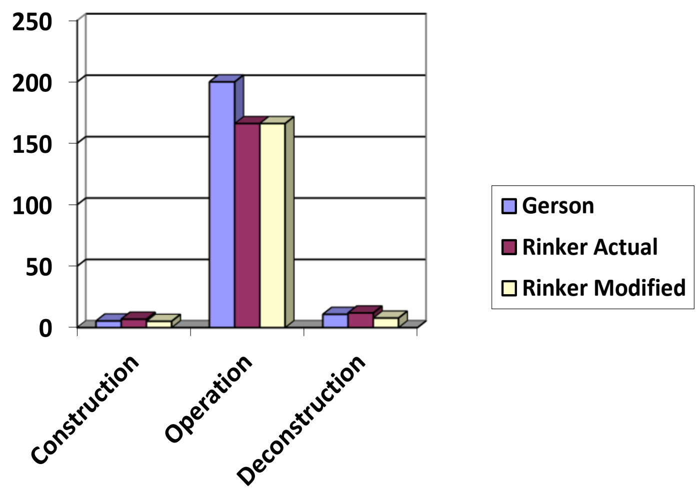


Figure 4-15. Tool for Reduction and Assessment of Chemical Impacts (TRACI), global warming air [kg CO_2-Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

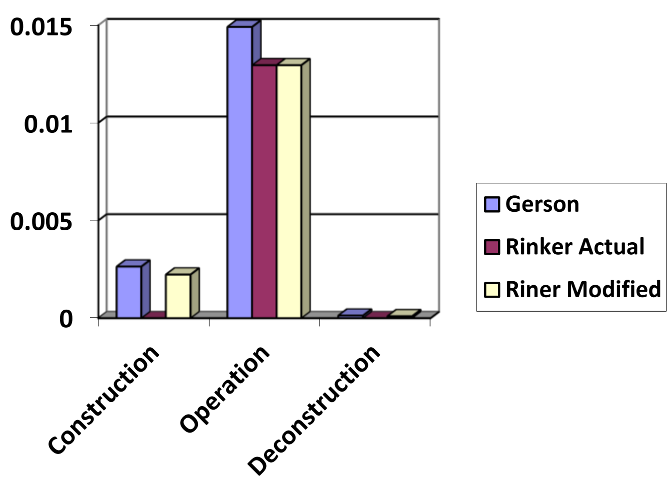


Figure 4-16. TRACI, human health cancer air [kg Benzene-Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

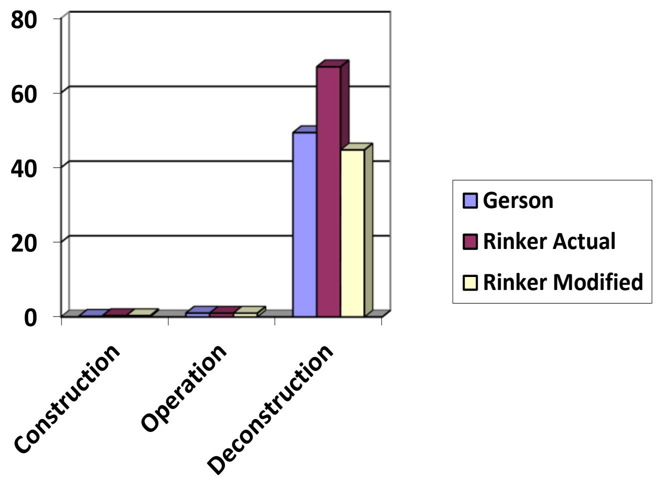


Figure 4-17. TRACI, human health cancer ground-surface soil [kg Benzene-Equiv.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

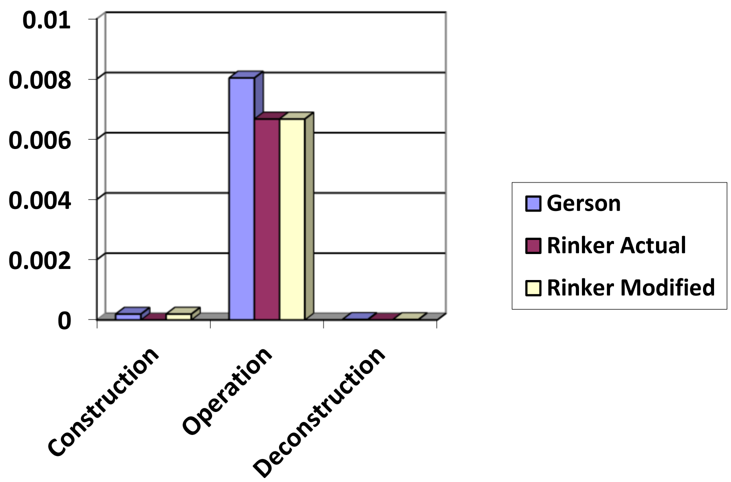


Figure 4-18. TRACI, human health cancer water [kg Benzene-Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

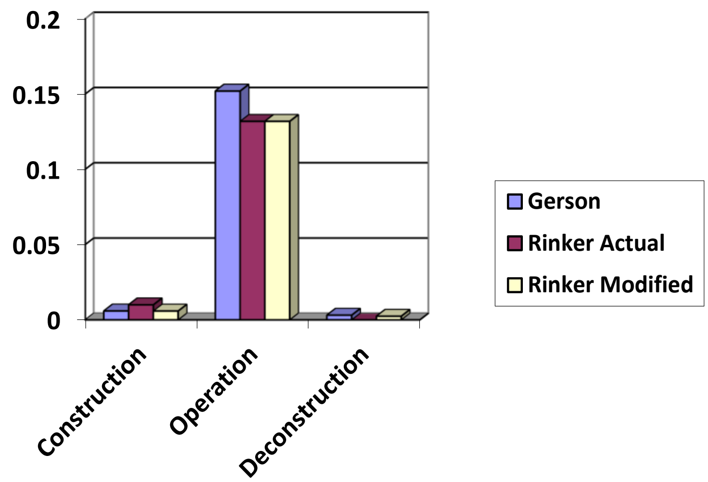


Figure 4-19. TRACI, human health criteria air-point source [kg PM2,5-Equiv/m2/yr.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

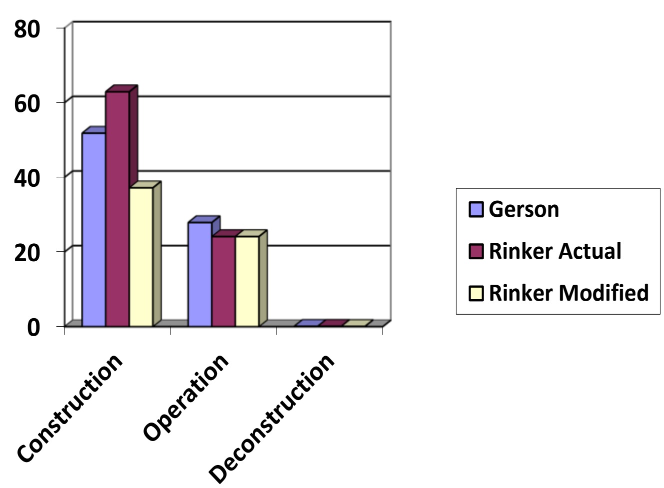


Figure 4-20. TRACI, human health non cancer air [kg Toluene-Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

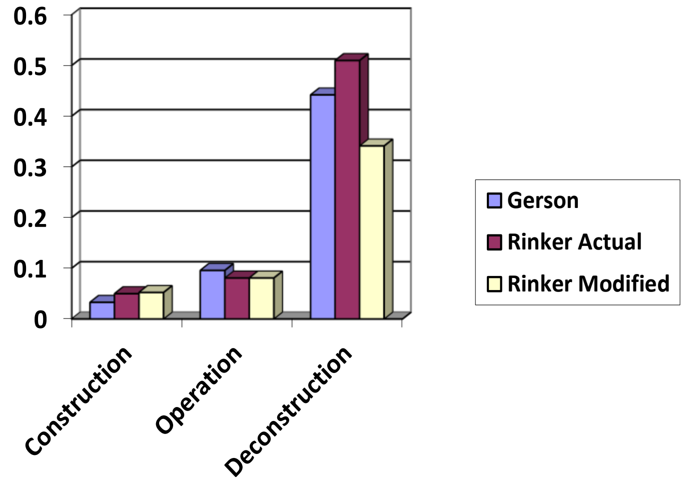


Figure 4-21. TRACI, human health non cancer ground-surface soil [kg Toluene-Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

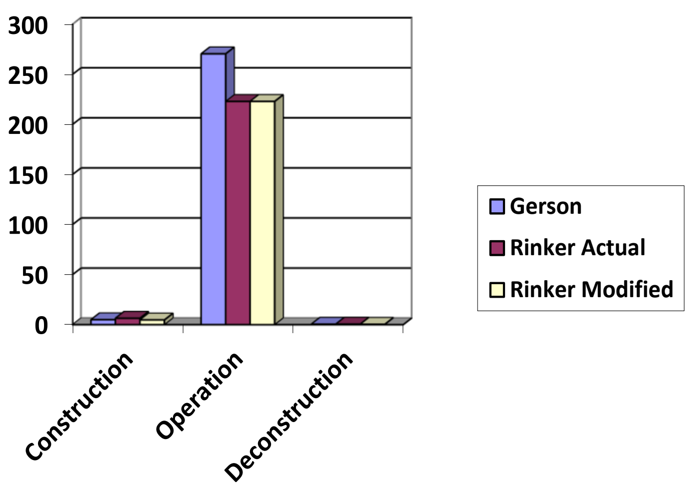


Figure 4-22. TRACI, human health non cancer water [kg Toluene-Equiv/m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

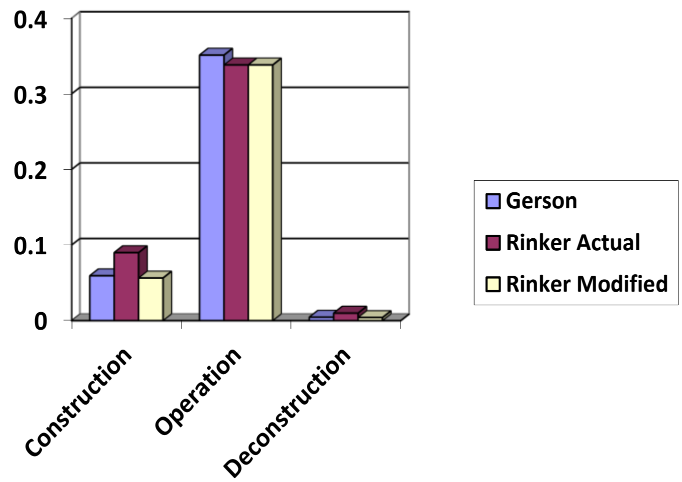


Figure 4-23. TRACI, ozone depletion air [kg CFC 11-Equiv.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

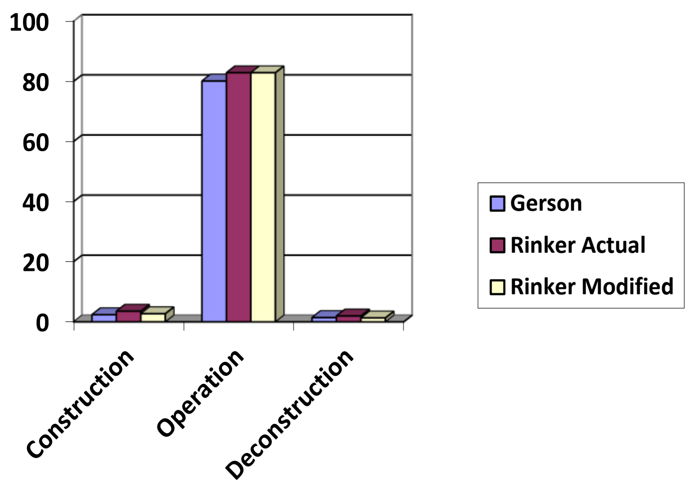


Figure 4-24. TRACI, smog air [kg NOx-Equiv.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

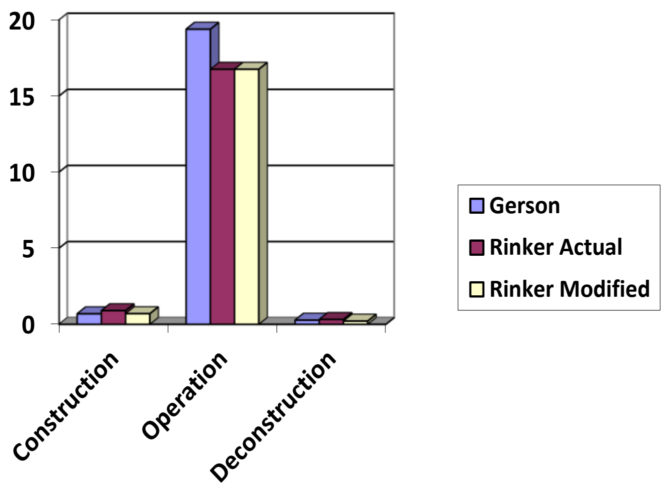


Figure 4-25. TRACI, acidification air [mol H+ Equiv./m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

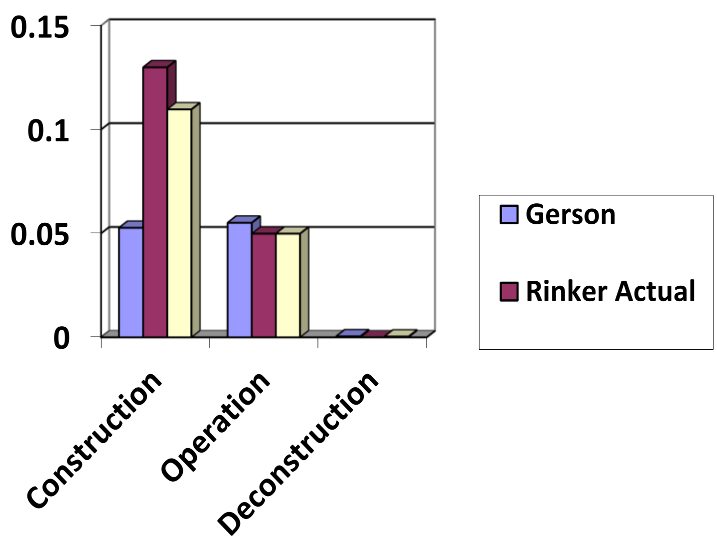


Figure 4-26. TRACI, ecotoxcity Air [kg 2,4-Dichlorophenoxyace/m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

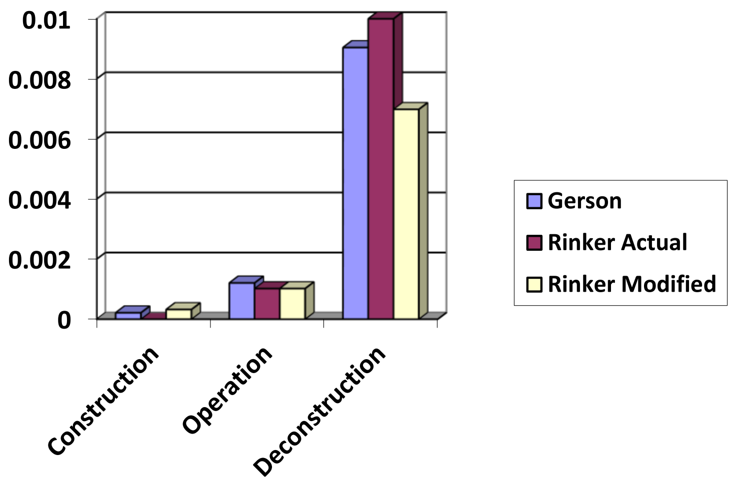


Figure 4-27. TRACI, ecotoxcity ground-surface soil [kg Benzene-Equiv.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

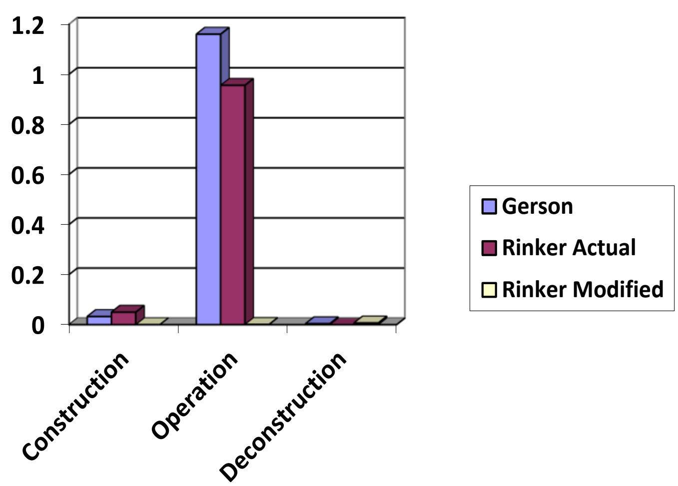


Figure 4-28. TRACI, ecotoxcity water [kg 2,4-Dichlorophenoxyace/m2/yr] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

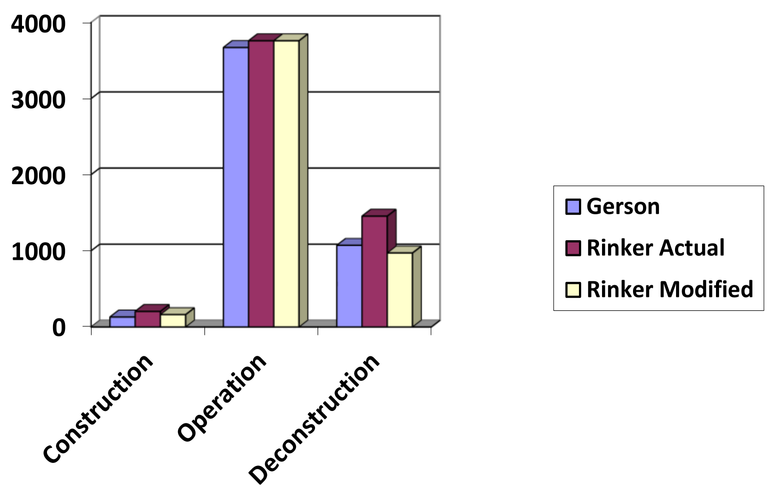


Figure 4-29. TRACI, eutrophication [kg N-Equiv.] from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

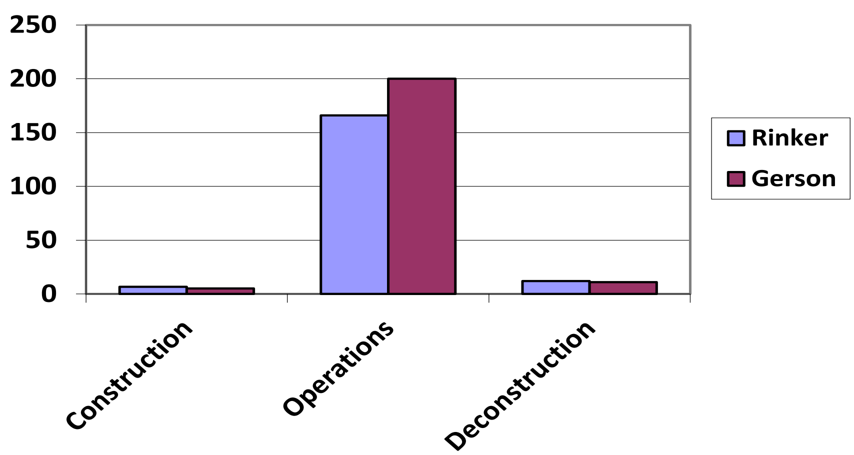


Figure 4-30. Comparison of measured life cycle phases carbon in CO_2 equiv./m2/yr from Gerson, Rinker actual, and Rinker with recommended change of 50% reduction in concrete

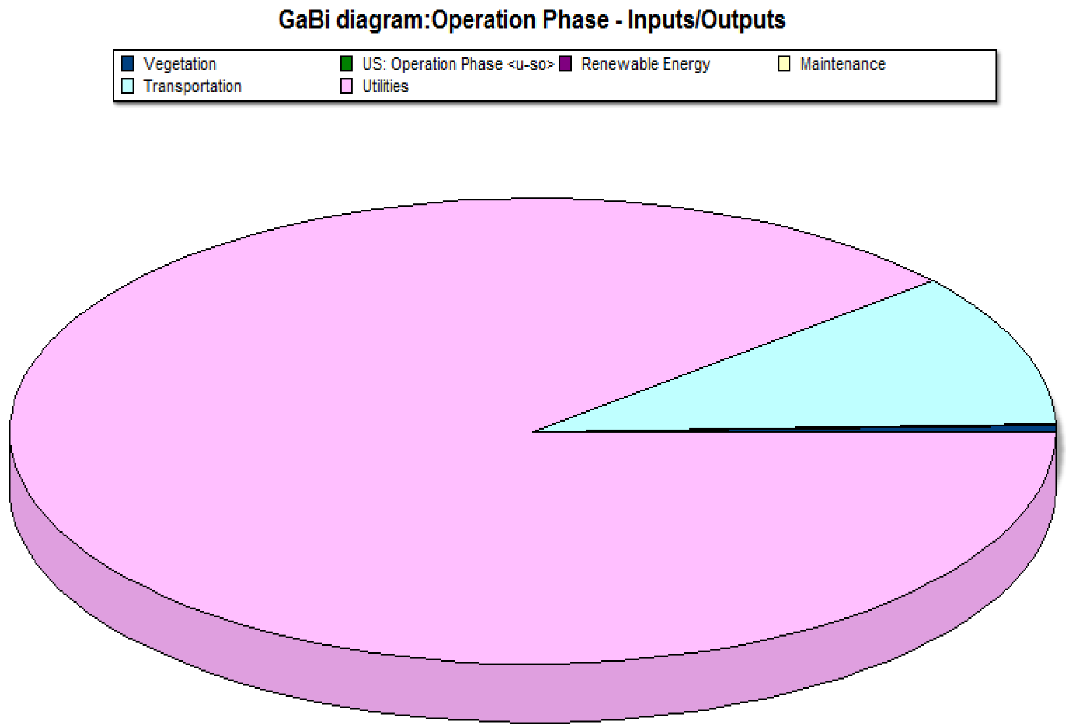


Figure 4-31. Rinker actual operation phase distribution by percentage

CHAPTER 5
DISCUSSION, CONCLUSION, THE FUTURE

Discussion

The overall intention of the carbon measuring is to find a method to evaluate materials and processes based upon a similar constraint. Ideally when an organization establishes a requirement to have buildings constructed to a particular sustainable rating system level, it will be recognized as comparable to similar levels in other nations. Although the most important constraint is to provide an effective system that can improve the environmental performance of facilities by establishing results that accurately reflect the actual building conditions.

In recognizing that a number of pollutants are released in the extracting, processing, and manufacturing of products, the decision to monitor ecological impacts should begin from the time the material is created and continue through the life of the product until it is finally disposed or recycled. Recognizing the importance of reducing the dependence on fossil fuels, plus minimizing the effect of power generated from carbon based products, and also examining the contributions of greenhouse gases – can all be analyzed through the atmospheric emissions. Tracking the life cycle carbon is an important step toward improving the environmental performance of buildings.

Carbon Emissions from Other Rating Systems

As the research demonstrated, the results from other rating systems were relatively consistent yet underestimated the carbon footprinting. The differences in sources between various countries may have been a factor for some of the variations in quantities; but for the most part it was insignificant. The major factor in the variations can be attributed to the data ranges that were being collected as part of the evaluation.

For example, some calculations included individual vehicle traffic and others did not. There were no two rating systems that could be identified as being exactly alike; and thus none that included the full range of processes in the building life cycle. As an indicator of these differences, it is interesting to note how the various rating systems would be adjusted based on the actual measurements from the Rinker building as depicted in figure 5-1. In most cases, the carbon emissions increased doubled from their calculations in figure 4-6. One of the contributing factors to these changes could be seen in figure 5-2 as it depicts the various levels of carbon emissions from energy production based on the different rating systems.

In general, the scoring of the sustainable facilities put them in a close percentage of the available points. However, some countries had more restrictive requirements that resulted in final ranking that was at a lower percentage than others. For the non-LEED building, it was interesting to note that some nations had a higher overall standard that resulted in the building being ranked at a lower level. As some of the research on building construction practices indicated, several of the other nations have much more stringent emissions and energy requirements and thereby have established a more sustainable baseline for their buildings. As a result of the updated readings for the Rinker building, all of the rating systems would have given the building a lower rating than planned and in the case of Green Star the building would no longer qualify as a sustainable facility. Figure 5-3 depicts the anticipated new percentage of points the rating systems could provide to the actual conditions for the Rinker building.

Limitations of the Life Cycle Assessment for Building Rating System Program

One of the primary limitations in LCA investigations is getting accurate data to reflect the exact material that is being used. Fortunately, there are significant similarities in parallel processes as long as they abide by a consistent procedure for documenting the processes such as the ISO 14040 standards (International Organization for Standardization 2006b) For the developed model, US systems were chosen when available; although Germany was often the default scenario. The model is designed to permit easy alteration of the databases as US data (or other nations) becomes available.

Another significant limitation of the LCABRS program is that it is not free software. The basic program including database updates can be relatively expensive to purchase. Although, this is a problem with many of the improved rating tools, it seems to be further exasperated with GaBi in that a dongle is required to be installed on the computer in order to permit access to the program and databases.

Differences between Planned Results and Constructed Results

In the post construction case study, a significant deviation was noted between the planned energy usage and the actual recorded data for the LEED certified building. The direct energy measurements as compared to the energy modeling indicated that a 83% variation had occurred in electricity, a 393% variation in chilled water, and a 60% variation in steam. The corresponding change in carbon emissions also indicates a difference of 87 kg $CO_2/m^2/yr$ which would account in a 110% increase in the operational phase. The reasons for this deviation can be attributed to a wide variety of factors ranging from inaccurate data during the design phase, construction not occurring as planned, and/or operation of the building deviating from the modeled process (Bordass, Cohen & Field 2004).

With this type of variations in actual versus planned energy usage, it is understandable why building rating systems have received the criticism of individuals such as Henry Gifford (Gifford 2009). By using accurate carbon calculating tools such as the LCABRS model, more realistic evaluations could be achieved. The rating systems could then be tied directly to a measured percentage reduction from a baseline facility in order to obtain certification. By proving a carbon reduction of 30, 40, or 50% could result in award levels of Silver, Gold or Platinum. Naturally, the percentage of emission savings necessary for building certification should be similar to an international level to permit consistency in reporting standards.

Publicity of the LCABRS model is important in expanding the knowledge of the technique and encouraging further development and research. Through awareness of the importance of this type of tool in building evaluations, it is possible to make a significant difference in the selection of building materials and the operating principles of facilities. Distribution of the research results to building rating systems committees may inform them of the significance of full life cycle consideration and provide the impetus for improving the various systems.

Conclusion

In recapping the goals of this project, the research was successful in demonstrating the differences in carbon footprinting calculations between a sustainable rated facility and a non-sustainable rated facility. The LCABRS model was able to demonstrate that the major differences occur in the building operation cycle although to fully understand the buildings impact, the full life cycle should be considered. By looking at the predominant international rating systems, it could be seen how other nations would evaluate similar buildings and an enhanced method could be developed that provided a more detailed calculation of the carbon footprint.

Additionally, the research was effective in demonstrating that international rating systems may have very different goals for their building evaluation and that it is important to understand these variations before trying to equate one system's results directly to another rating system. Despite the fact that several systems use carbon emissions as a factor for building evaluation, since they do not consider the same building processes, it would be erroneous to attempt to develop direct correlations between these systems based on their current methods of calculating carbon footprint.

The LCABRS model validation and Case Study have demonstrated that the null hypothesis has been supported and a method can be developed that correlates building rating systems with carbon footprint calculations for the full life cycle of the building. As Trusty states in his 2009 article about incorporating LCAs into building rating systems (Trusty 2009):

> "the reality is that most building products have both positive and negative aspects when it comes to environmental performance. The task is to balance the pros and cons, understand the trade-offs in terms of true environmental performance measures, and use materials to their best advantage, recognizing that all buildings typically incorporate a wide range of materials.

Although the planned energy demands can be helpful for establishing an energy goal, it should not be the final determinant in establishing the sustainability of the facility. An energy rating should be based on actual verifiable results for the facility. It is imperative of Construction Managers and Facility Managers to understand what can cause these variations and plan to take corrective action early to avoid greater deviations.

An LCA for a facility to be comprehensive needs to include the full range of impacts from construction through operation and finally consider the demolition at the end of life. The LCABRS model is able to provide a simplified analysis of the data based on the majority of factors affecting the full building process. An understanding of the interrelation of these factors is important for facility owners and operators to help in establishing objectives for reducing the carbon foot-print of their building.

The developed LCABRS model is not intended as a panacea but rather a tool that can assist with the interpretation of the full life cycle process. As this technology grows, it can become a valuable portion of the building evaluation process to document the performance and environmental impacts from decisions made concerning the building design, operation, and disposal.

Returning to the original intent of providing an analysis tool that looks at sustainability, the LCABRS model is well situated for considering the carbon footprint and in conjunction with the other LCIA criteria can look at other life cycle environmental impacts. Additionally, the LCABRS program has been designed to permit analysis of other sustainable criteria such as ecological and social impacts. Although currently, the amount of data available for social impacts is very limited and an excellent area for future research.

Future Research

The level of data available for life cycle assessments on products is still very limited. Although routine products can be found, the more elaborate manufacturing process, particularly in non-EU countries, often lack the full environmental emission data or have not even been modeled. Naturally, the accuracy of the life cycle analysis depends on the available database. Thus, it cannot be overstated that, more research is needed on construction materials in order to improve the validity of the results and enhance the decision making process.

There are still significant gaps in the modeling process relative to the energy and resources used in the actual building construction process. Despite numerous reviews of the construction process from a management perspective, there is limited data on the ecological factors. Despite this being a relatively minor component of the overall building life, it would still be necessary to provide informed decisions that could impact the environmental impacts during on site building construction. Factors such as equipment usage, site layout, material storage, and utility usage, would be valuable to have analyzed.

It would be worthwhile to develop a database of buildings that can be used to establish a baseline for evaluating the sustainability of facilities. With the baseline and subsequent range of results from measured facilities, it can be determined relatively how sustainable a building actually performs. The intent would be to require this kind of information as part of any rating system and publicize the results. Awareness of the importance of sustainable buildings is a key element in increasing the incorporation of these ideas and truly making a difference in the world.

As the implementation of Building Information Modeling (BIM) becomes more prevalent it would be useful to establish a direct link between the results of the BIM program and the LCABRS model. As the LCABRS model is designed to accept inputs in the CSI Masterformat style and the BIM model can produce material take-offs in the same style, there would be a useful link between these two tools. Ideally, the LCABRS model should be automated to a point where users would take advantage of the program through other design tools and provide a seamless interpretation of the sustainability of the building that can be evaluated virtually continuously through the design process

It would be of interest for design professionals to have a single tool that could perform all the calculations instantaneously. As previously mentioned, the LCABRS model was not designed to perform any energy modeling. It could save on several steps and improve the accuracy of results if the energy modeling could be built into the LCA tool.

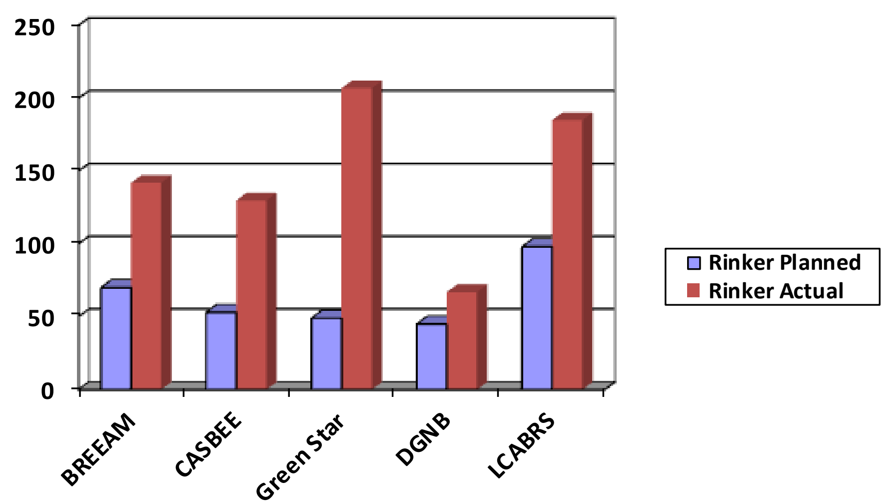


Figure 5-1. Rating systems calculated carbon footprint for Rinker in kg CO_2 equiv./m^2/yr

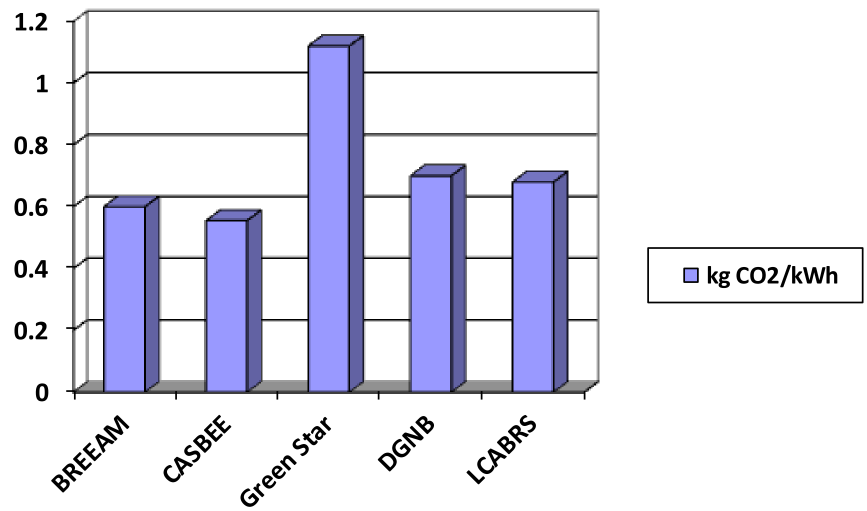


Figure 5-2. Rating systems reported carbon factor for energy

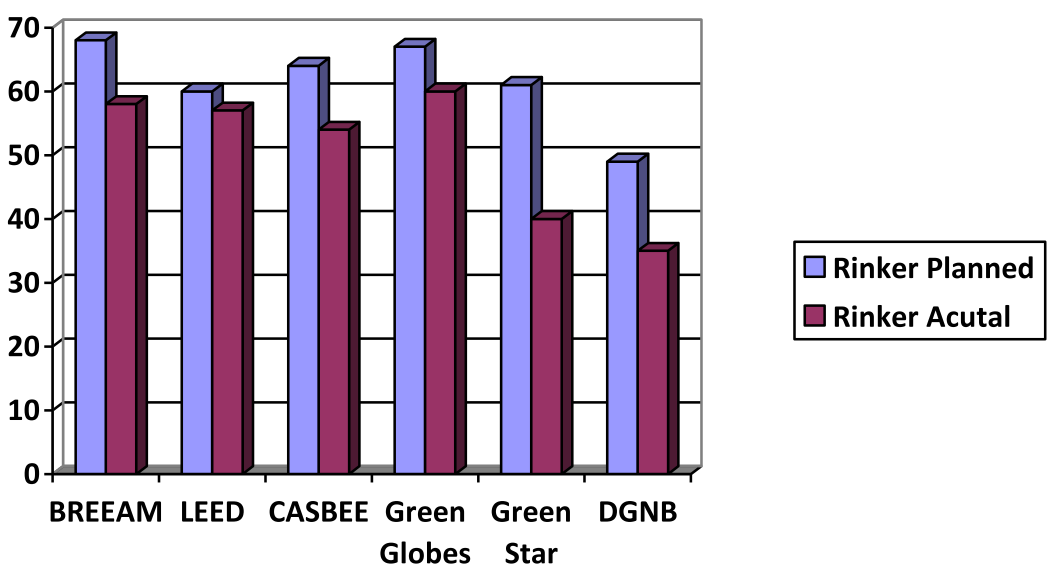


Figure 5-3. Percentage of rating systems points earned

APPENDIX A
MATERIAL TAKE OFF

Division			item	units	Rinker	Gerson	Difference
Division 2		Site Construction					
	2510	Trees					
			CrapeMyrtle	ea	4		
			Elm 8'	2a	21		
			Live Oak 8'	ea	2		
			European Palm	ea	2		
			Saw palmetto	ea	3		
			sago palm	ea	5		
			sabal palm	ea	4		
	2520	Shrubs					
			Podocarpus	ea	6		
			Blush	ea	16		
			Azalea	ea	74		
			Camelia	ea	4		
	2530	Ground Cover					
			Hawthorn	ea	22		
			Jasmine	ea	20		
			Evergreen Giants	ea	10		
			Variegater	ea	48		
			Parsonil	ea	81		
			Creeping Fig	ea	31		
	2540	Seed and Sod					
			Bermuda sod	sf	37287		
Division 3		Concrete					
	3050	Basic Concrete Materials and					

		Methods					
	3100	Concrete Forms and Accessories					
				sfca	7107.44		7107.44
	3200	Concrete Reinforcement					
			wwf	sf	74789.5	79659.29	-4869.79
			rebar	lbs	113588.246	18711.74	94876.51
	3300	Cast-In-Place Concrete					
				cy	580.57	219.2783	361.29
			Finishing	sf	72973.28		72973.28
			Curing	csf	793.60		793.60
	3400	Precast Concrete					
	3500	Cementitious Decks and Underlayment					
				cy	827.13	870.308	-43.17
	3600	Grouts					
	3700	Mass Concrete					
	3900	Concrete Restoration and Cleaning					
Division 4		Masonry	4000 Masonry				
	4050	Basic Masonry Materials and Methods					
	4100	Joint Reinforcement					
			wall ties	ea	5198		5197.50
			horiz. reinforcement	lf	3524		3524.00
			mortar	cf	909.00	787.5728	121.43
			grout	cf		1682.797	-1682.80
	4200	Masonry Units					
			6" CMU	blocks	4600.00		4600.00
			8" CMU	blocks	109.62	27688.11	-27578.49
			Brick	ea	56554.68	153087.	-96533.13

						8	
	4400	Stone					
	4500	Refractories					
	4600	Corrosion-Resistant Masonry					
	4700	Simulated Masonry					
	4800	Masonry Assemblies					
	4900	Masonry Restoration and Cleaning					
Division 5		Metals					
	5050	Basic Metal Materials and Methods					
	5100	Structural Metal Framing					
			columns	tons	63	15.7649 9	46.75
			beams	tons	133.5	135.352 4	-1.85
			tube steel	tons	69		69.00
	5200	Metal Joists					
	5300	Metal Deck					
			2"	sf		29263.7 2	-29263.72
			3"	sf	32800	12914.5 3	19885.47
			1.5"	sf	15025	2740.42 9	12284.57
	5400	Cold-Formed Metal Framing					
			metal studs	ea	3000		3000.00
	5500	Metal Fabrications					
			anchor bolts	ea	180	72	108.00
			base plates	tons	2.50	0.43385 4	2.07
	5600	Hydraulic Fabrications					
	5700	Ornamental Metal					
	5800	Expansion Control					
	5900	Metal Restoration and Cleaning					

Division 6		Wood and Plastics						
	6050	Basic Wood and Plastic Materials and Methods						
	6100	Rough Carpentry						
				wood blocking	bf	4614.13333	6915.301	-2301.17
				3/4" sheathing	sf	14029.256	13061.57	967.69
				5/8" sheathing	sf		2006.4	-2006.40
	6200	Finish Carpentry						
	6400	Architectural Woodwork						
	6500	Structural Plastics						
	6600	Plastic Fabrications						
	6900	Wood and Plastic Restoration and Cleaning						
Division 7		Thermal and Moisture Protection						
	7050	Basic Thermal and Moisture Protection Materials and Methods						
	7100	Dampproofing and Waterproofing						
				vapor barrier	sf	1225	70494.95	-69269.95
				Bentonite	sf	1947		1947.00
				damproofing	sf		524136.3	-524136.31
				sealants	lf	2492		2492.00
	7200	Thermal Protection						
				rigid	1.5"		524136.3	-524136.31
					2.5"		17906.01	-17906.01
				batt			5910.4	-5910.40
	7300	Shingles, Roof Tiles, and Roof Coverings						
			clay	roof tiles	sf		13061.57	-13061.57
	7400	Roofing and Siding Panels						

			aluminum panels	sf	16300	504.012 8	15795.99
			copper panels	sf		1687.36	-1687.36
	7500	Membrane Roofing					
			modified bituminous			4844.44 2	-4844.44
			EPDM	sf	17300		17300.00
	7600	Flashing and Sheet Metal					
			flat seam copper			611.686 4	-611.69
			Flashing	lf	700	2092.32	-1392.32
	7700	Roof Specialties and Accessories					
			copper fascia			533.92	-533.92
			Gutters			436.32	-436.32
			downspounts			14	-14.00
	7800	Fire and Smoke Protection					
	7900	Joint Sealers					
Division 8		Doors and Windows					
	8050	Basic Door and Window Materials and Methods					
	8100	Metal Doors and Frames					
			exterior	sf	780.39	328.9	451.49
			interior	sf		679.691 7	-679.69
	8200	Wood and Plastic Doors					
				sf	1487.41	2365.13 7	-877.73
	8300	Specialty Doors					
	8400	Entrances and Storefronts					
	8500	Windows					
				sf		2583.03 6	-2583.04
	8600	Skylights					
				sf	686		686.00
	8700	Hardware					
	8800	Glazing					

	8900	Glazed Curtain Wall					
				sf	10243.84	2471.654	7772.19
Division 9		Finishes					
	9050	Basic Finish Materials and Methods					
	9100	Metal Support Assemblies					
	9200	Plaster and Gypsum Board					
				sf		68142.6	-68142.60
	9300	Tile					
	9400	Terrazzo					
	9500	Ceilings					
			Ultima 1912	sy		90.51022	-90.51
			Cirrus 584	sy		2122.773	-2122.77
			Perforated metal	sy		926.3246	-926.32
	9600	Flooring					
			Carpet	sf		22616.87	-22616.87
			Tile	sf		1506.918	-1506.92
	9700	Wall Finishes					
	9800	Acoustical Treatment					
	9900	Paints and Coatings					
				sf		79635.76	-79635.76
							0.00

APPENDIX B
BUILDING RESEARCH ESTABLISMENT ENVIRONMENTAL ASSESSMENT METHOD SCORECARD

breeam

BREEAM Education 2008 Pre-Assessment Estimator

Indicative Overall BREEAM Score
67.51%

BREEAM Rating Benchmarks	
PASS	≥30
GOOD	≥45
VERY GOOD	≥55
EXCELLENT	≥70
OUTSTANDING*	≥85

Ref	BREEAM Issue Title	BREEAM Education - Further Education Issue Criteria	Number of BREEAM credits available	Total predicted BREEAM credits achieved	Minimum BREEAM Standards: Pass	Good	Very Good	Excellent	Outstanding
					NO	NO	NO	NO	NO
					Minimum required credits by BREEAM issue and rating				
Management									
Man 1	Commissioning	One credit where evidence provided demonstrates that an appropriate project team member has been appointed to monitor commissioning on behalf of the client to ensure commissioning will be carried out in line with current best practice. Two credits where, in addition to the above, evidence provided demonstrates that seasonal commissioning will be carried out during the first year of occupation, post construction (or post fit out).	2	2	1	1	1	1	2
Man 2	Considerate Constructors	One credit where evidence provided demonstrates that there is a commitment to comply with best practice site management principles. Two credits where evidence provided demonstrates that there is a commitment to go beyond best practice site management principles.	2	1	-	-	-	1	2
Man 3	Construction Site Impacts	One credit where evidence provided demonstrates that 2 or more of items a-g (listed below) are achieved. Two credits where evidence provided demonstrates that 4 or more of items a-g (listed below) are achieved. Three credits where evidence provided demonstrates that 6 or more of items a-g are achieved: a. Monitor, report and set targets for CO2 or energy arising from site activities b. Monitor, report and set targets for CO2 or energy arising from transport to and from site c. Monitor, report and set targets for water consumption arising from site activities d. Implement best practice policies in respect of air (dust) pollution arising from the site e. Implement best practice policies in respect of water (ground and surface) pollution occurring on the site f. Main contractor has an environmental materials policy, used for sourcing of construction materials to be utilised on site g. Main contractor operates an Environmental Management System. One additional credit where evidence provided demonstrates that at least 80% of site timber is responsibly sourced and 100% is legally sourced.	4	1	-	-	-	-	-

Man 4	Building user guide	One credit where evidence provided demonstrates the provision of a simple guide that covers information relevant to the tenant/occupants and non-technical building manager on the operation and environmental performance of the building.	1	0	-	-	-	1	1
Man 5	Site Investigation	One credit where evidence provided demonstrates that the design team has carried out a detailed site investigation of the selected site.	1	1	-	-	-	-	-
Man 6	Consultation	One credit where evidence provided demonstrates that consultation has been, or is being, undertaken and feedback given to the local community and building users. Two credits where, in addition to the above, evidence provided demonstrates that the consultation process is being, or has been, undertaken using an independent method such as DQI, DQM or School Works, facilitated by a third party.	2	0	-	-	-	-	-
Man 7	Shared Facilities	One credit where evidence provided demonstrates that shared facilities have been provided as a consequence of consultation feedback. Two credits where, in addition to the above, evidence provided demonstrates that these facilities can be accessed without compromising the safety and security of the building and its occupants.	2	1	-	-	-	-	-
Man 8	Security	One credit where evidence provided demonstrates that an Architectural Liaison Officer (ALO) or Crime Prevention Design Advisor (CPDA) from the local police force has been consulted at the design stage and their recommendations incorporated into the design of the building and its parking facilities (if relevant).	1	0	-	-	-	-	-
Man 9	Publication of building information	One credit where evidence provided demonstrates that the design team are committed to publicising information about the environmental performance of the new development via the internet, newsletters, site visits, presentations etc.	1	1	-	-	-	-	1
Man 10	Development as a learning resource	One credit where evidence provided demonstrates that the proposed building AND/OR landscape design provides a learning resource that can be used to facilitate development of environmental issues for building users and visitors.	1	1	-	-	-	-	1
Man 11	Ease of Maintenance	One credit where evidence provided demonstrates that specifications for the building and the building services/systems and landscaping have considered ease and efficiency of maintenance in line with best practice.	1	0	-	-	-	-	-
Man 12	Life Cycle Costing	One credit where evidence provided demonstrates that a Life Cycle Cost (LCC) analysis based on the feasibility study proposals has been undertaken on the building design at a strategic and system level. Two credits where, in addition to the above, evidence provided demonstrates that the results of the feasibility study and consideration of LCC have been implemented.	2	0	-	-	-	-	-

Indicative Management (weighted) Section Score 4.80%

Health & Wellbeing

Hea 1	Daylighting	One credit where evidence provided demonstrates that at least 80% of floor area in each occupied space is adequately daylit.	1	1	-	-	-	-	-
Hea 2	View Out	One credit where evidence provided demonstrates that all relevant building areas have an adequate view out.	1	0	-	-	-	-	-
Hea 6	Lighting zones & controls	One credit where evidence provided demonstrates that, in all relevant building areas, lighting is appropriately zoned and occupant controllable with the option for commonly required lighting settings to be selected quickly and easily.	1	1	-	-	-	-	-
Hea 7	Potential for natural ventilation	One credit where evidence provided demonstrates that fresh air is capable of being delivered to the occupied spaces of the building via a natural ventilation strategy, and there is sufficient user-control of the supply of fresh air.	1	0	-	-	-	-	-
Hea 8	Indoor air quality	One credit where air intakes serving occupied areas avoid major sources of external pollution and recirculation of exhaust air.	1	1	-	-	-	-	-
Hea 9	Volatile Organic Compounds	One credit where evidence provided demonstrates that the emissions of VOCs and other substances from key internal finishes and fittings comply with best practice levels.	1	1	-	-	-	-	-
Hea 10	Thermal comfort	One credit where evidence provided demonstrates that thermal comfort levels in occupied spaces of the building are assessed at the design stage to evaluate appropriate servicing options, ensuring appropriate thermal comfort levels are achieved.	1	1	-	-	-	-	-
Hea 11	Thermal zoning	One credit where evidence provided demonstrates that local occupant control is available for temperature adjustment in each occupied space to reflect differing user demands.	1	1	-	-	-	-	-
Hea 12	Microbial contamination	One credit where evidence provided demonstrates that the risk of waterborne and airborne legionella contamination has been minimised.	1	0	1	1	1	1	1

Energy

Ene 1	Reduction of CO2 Emissions	Up to fifteen credits where evidence provided demonstrates an improvement in the energy efficiency of the building's fabric and services and therefore achieves lower building operational related CO2 emissions (refer to the BREEAM manual for benchmarks)	15	15	-	-	-	6	10
Ene 2	Sub-metering of Substantial Energy Uses	One credit where evidence provided demonstrates the provision of direct sub-metering of energy uses within the building.	1	0	-	-	1	1	1
Ene 3	Sub-metering of high energy load Areas and Tenancy	One credit where evidence provided demonstrates sub-metering of energy consumption by tenancy/building function area is installed within the building.	1	0	-	-	-	-	-
Hea 13	Acoustic Performance	Two credits where evidence provided demonstrates that all spaces in the building achieve, and for the relevant areas exceed, the performance standards required by Building Bulletin 93 for indoor ambient noise levels and reverberation times.	2	2	-	-	-	-	-
Hea 16	Drinking Water	One credit where evidence provided demonstrates that mains-fed point of use water coolers are provided for building occupants use throughout the day.	1	1	-	-	-	-	-
		Indicative Health & Wellbeing (weighted) Section Score	12.00%						

Ene 4	External Lighting	One credit where energy-efficient external lighting is specified and all light fittings are controlled for the presence of daylight.	**1**	**1**	-	-	-	-	-
Ene 5	Low zero carbon technologies	One credit where evidence provided demonstrates that a feasibility study considering local (on-site and/or near site) low or zero carbon (LZC) technologies has been carried out and the results implemented. Two credits where evidence provided demonstrates that the first credit has been achieved and there is a 10% reduction in the building's CO2 emissions as a result of the installation of a feasible local LZC technology. Three credits where evidence provided demonstrates that the first credit has been achieved and there is a 15% reduction in the building's CO2 emissions as a result of the installation of a feasible local LZC technology. Or alternatively: A maximum of one credit where evidence provided demonstrates that a contract with an energy supplier is in place to provide sufficient electricity used within the assessed building/development to meet the above criteria from a 100% renewable energy source. (Note: a standard Green Tariff will not comply)	**3**	**0**	-	-	-	1	1
Ene 8	Lifts	Up to two credits are available where evidence provided demonstrates the installation of energy-efficient lift(s).	**2**	**2**	-	-	-	-	-
Ene 10	Free Cooling	One credit where evidence provided demonstrates the building incorporates a free cooling strategy that completely displaces the need for conventional mechanical cooling systems (excluding exceptional localised circumstances with small scale systems, for example server rooms) and the thermal comfort requirements of credit Hea 10 are achieved.	**1**	**0**	-	-	-	-	-
		Indicative Energy (weighted) Section Score	14.25%						

Transport

Tra 1	Provision of public transport	Up to five credits are awarded on a sliding scale based on the assessed buildings' accessibility to the public transport network.	**5**	**5**	-	-	-	-	-
Tra 2	Proximity to amenities	One credit where evidence provided demonstrates that the building is located within 500m of accessible local amenities appropriate to the building type and its users.	**1**	**1**	-	-	-	-	-
Tra 3	Cyclist Facilities	One credit where evidence provided demonstrates that covered, secure and well-lit cycle storage facilities are provided for all building users. Two credits where, in addition to the above, adequate changing facilities are provided for staff use.	**2**	**0**	-	-	-	-	-
Tra 4	Pedestrian and cycle safety	One credit where evidence provided demonstrates that the site layout has been designed in accordance with best practice to ensure safe and adequate pedestrian and cycle access.	**1**	**1**	-	-	-	-	-

Tra 5	Travel plan	One credit where evidence is provided to demonstrate that a travel plan has been developed and tailored to the specific needs of the building users.	1	0	-	-	-	-	-
		Indicative Transport (weighted) Section Score	5.60%						
Water									
Wat 1	Water Consumption	Up to three credits where evidence provided demonstrates that the specification includes taps, urinals, WCs and showers that consume less potable water in use than standard specifications for the same type of fittings.	3	3	-	1	1	1	2
Wat 2	Water meter	One credit where evidence provided demonstrates that a water meter with a pulsed output will be installed on the mains supply to each building/unit.	1	0	-	1	1	1	1
Wat 3	Major leak detection	One credit where evidence provided demonstrates that a leak detection system is specified or installed on the building's water supply.	1	0	-	-	-	-	-
Wat 4	Sanitary supply shut off	One credit where evidence provided demonstrates that proximity detection shut-off is provided to the water supply to all toilet areas.	1	0	-	-	-	-	-
Wat5	Water recycling	One credit where evidence provided demonstrates the specification of systems that collect, store and, where necessary treat, rainwater or greywater for WC and urinal flushing purposes.	1	1	-	-	-	-	-
Wat 6	Irrigation systems	One credit where evidence provided demonstrates that a low-water irrigation strategy/system has been installed, or where planting and landscaping is irrigated via rainwater or reclaimed water.	1	1	-	-	-	-	-
		Indicative Water (weighted) Section Score	3.75%						
Materials									
Mat 1	Materials Specification (major building elements)	Up to six credits are available, determined by the Green Guide to Specification ratings for the following major building/finishing elements: 1. External Walls 2. Windows 3. Roof 4. Upper Floor Slabs 5. Internal Walls 6. Floor Finishes / Coverings	6	3	-	-	-	-	-
Mat 2	Hard landscaping and boundary protection	One credit where evidence provided demonstrates that at least 80% of the combined area of external hard landscaping and boundary protection specifications achieve an A or A+ rating, as defined by the Green Guide to Specification.	1	1	-	-	-	-	-
Mat 3	Re-use of building façade	One credit is awarded where evidence provided demonstrates that at least 50% of the total façade (by area) is reused and at least 80% of the reused façade (by mass) comprises in-situ reused material.	1	0	-	-	-	-	-
Mat 4	Re-use of building structure	One credit is awarded where evidence provided demonstrates that a design reuses at least 80% of an existing primary structure and for part refurbishment and part new build, the volume of the reused structure comprises at least 50% of the final structure's volume.	1	0	-	-	-	-	-

Mat 5	Responsible sourcing of materials	Up to 3 credits are available where evidence provided demonstrates that 80% of the assessed materials in the following building elements are responsibly sourced: a. Structural Frame b. Ground floor c. Upper floors (including separating floors) d. Roof e. External walls f. Internal walls g. Foundation/substructure h. Staircase Additionally 100% of any timber must be legally sourced.	3	0	-	-	-	-	-
Mat 6	Insulation	One credit where evidence provided demonstrates that thermal insulation products used in the building have a low embodied impact relative to their thermal properties, determined by the Green Guide to Specification ratings. One credit where evidence provided demonstrates that thermal insulation products used in the building have been responsibly sourced.	2	0	-	-	-	-	-
Mat 7	Designing For Robustness	One credit where protection is given to vulnerable parts of the building such as areas exposed to high pedestrian traffic, vehicular and trolley movements.	1	0	-	-	-	-	-
		Indicative Materials (weighted) Section Score	3.33%						
Waste									
Wst 1	Construction Site Waste Management	Up to three credits are available where evidence provided demonstrates that the amount of non-hazardous construction waste (m3/100m2 or tonnes100m2) generated on site by the development is the same as or better than good or best practice levels. One credit where evidence provided demonstrates that a significant majority of non-hazardous construction waste generated by the development will be diverted from landfill and reused or recycled.	4	4	-	-	-	-	-
Wst 2	Recycled aggregates	One credit where evidence provided demonstrates the significant use of recycled or secondary aggregates in 'high-grade' building aggregate uses.	1	1	-	-	-	-	-
Wst 3	Recyclable waste storage	One credit where a central, dedicated space is provided for the storage of the building's recyclable waste streams.	1	1	-	-	-	1	1
		Indicative Waste (weighted) Section Score	7.50%						
Land Use & Ecology									
LE1	Re-use of land	One credit where evidence provided demonstrates that the majority of the footprint of the proposed development falls within the boundary of previously developed land.	1	1	-	-	-	-	-
LE2	Contaminated land	One credit is awarded where evidence provided demonstrates that the land used for the new development has, prior to development, been defined as contaminated and where adequate remedial steps have been taken to decontaminate the site prior to construction.	1	0	-	-	-	-	-

LE3	Ecological value of site AND Protection of ecological features	One credit is awarded where evidence provided demonstrates that the construction zone is defined as land of low ecological value and all existing features of ecological value will be fully protected from damage during site preparation and construction works.	1	0	-	-	-	-	-
LE4	Mitigating Ecological impact	One credit where evidence provided demonstrates that the change in the site's existing ecological value, as a result of development, is minimal. Two credits where evidence provided demonstrates that there is no negative change in the site's existing ecological value as a result of development.	2	2	-	-	1	1	1
LE5	Enhancing Site Ecology	One credit where the design team (or client) has appointed a suitably qualified ecologist to advise and report on enhancing and protecting the ecological value of the site; and implemented the professional's recommendations for general enhancement and protection of site ecology. Two credits where, in addition to the above, there is a positive increase in the ecological value of the site of up to (but not including) 6 species. Three credits where, in addition to the above, evidence is provided to demonstrate a positive increase in the ecological value of the site of 6 species or greater.	3	0	-	-	-	-	-
LE6	Long term impact on biodiversity	One credit where the client has committed to achieving the mandatory requirements listed below and at least two of the additional requirements. Two credits where the client has committed to achieving the mandatory requirements listed below and at least four of the additional requirements.	2	0	-	-	-	-	-
		Indicative Land Use & Ecology (weighted) Section Score	3.00%						

Pollution

Pol 1	Refrigerant GWP - Building services	One credit where evidence provided demonstrates the use of refrigerants with a global warming potential (GWP) of less than 5 or where there are no refrigerants specified for use in building services.	1	1	-	-	-	-	-
Pol 2	Preventing refrigerant leaks	One credit where evidence provided demonstrates that refrigerant leaks can be detected AND that the provision of automatic refrigerant pump down is made to a heat exchanger (or dedicated storage tanks) with isolation valves. Or where there are no refrigerants specified for the development.	1	0	-	-	-	-	-
Pol 4	NOx emissions from heating source	One credit where evidence provided demonstrates that the maximum dry NOx emissions from delivered space heating energy are ≤100 mg/kWh (at 0% excess O2). Two credits where evidence provided demonstrates that the maximum dry NOx emissions from delivered space heating energy are ≤70 mg/kWh (at 0% excess O2). Three credits where evidence provided demonstrates that the maximum dry NOx emissions from delivered space heating energy are ≤40 mg/kWh (at 0% excess O2) and emissions from delivered water heating energy are 100 mg/kWh or less (at 0% excess O2).	3	3	-	-	-	-	-

Pol 5	Flood risk	Two credits where evidence provided demonstrates that the assessed development is located in a zone defined as having a low annual probability of flooding. One credit where evidence provided demonstrates that the assessed development is located in a zone defined as having a medium or high annual probability of flooding AND the ground level of the building, car parking and access is above the design flood level for the site's location. One further credit where evidence provided demonstrates that surface water run-off attenuation measures are specified to minimise the risk of localised flooding, resulting from a loss of flood storage on site due to development.	3	2	-	-	-	-	-
Pol 6	Minimising watercourse pollution	One credit here evidence provided demonstrates that effective on site treatment such as Sustainable Drainage Systems (SUDs) or oil separators have been specified in areas that are or could be a source of watercourse pollution.	1	0	-	-	-	-	-
Pol 7	Reduction of Night Time Light Pollution	One credit where evidence provided demonstrates that the external lighting design is in compliance with the guidance in the Institution of Lighting Engineers (ILE) Guidance notes for the reduction of obtrusive light, 2005.	1	1	-	-	-	-	-
Pol 8	Noise Attenuation	One credit where evidence provided demonstrates that new sources of noise from the development do not give rise to the likelihood of complaints from existing noise-sensitive premises and amenity or wildlife areas that are within the locality of the site.	1	1	-	-	-	-	-
		Indicative Pollution (weighted) Section Score	7.27%						

Innovation

Innovation	Man 2Considerate Constructors	Where post construction, a Considerate Constructors Scheme certificate can be provided demonstrating that the site achieved CCS Code of Considerate Practice with a score of at least 36. OR Where post construction, the site has complied in full with the alternative, independently assessed scheme, and the alternative scheme addresses all the mandatory and optional items in Checklist A2.	1	1
Innovation	Hea 1 Daylighting	At least 80% of the floor area (for the building spaces/room identified above in the standard requirements) has an average daylight factor of 3% in multi-storey buildings and 4% in single-storey buildings.	1	1
Innovation	Ene 1 Reduction of CO2 emissions	One additional innovation credit can be awarded where evidence provided demonstrates the building is designed to be a carbon neutral building as defined by the NCM (i.e. in terms of building services energy demand), as follows: a. A new building achieves a CO2 index less than 0 on the benchmark scale. b. A refurbished building achieves a CO2 index equal to or less than 0 on the benchmark scale. Two additional innovation credits can be awarded where evidence provided demonstrates the building is designed to be a True zero carbon building (in terms of building services and operational energy demand).	2	0

Innovation	Ene 5 Low or Zero Carbon Technologies	A local LZC energy technology has been installed in line with the recommendations of a compliant feasibility study and this method of supply results in a 20% reduction in the building's CO2 emissions.	1	0
Innovation	Wat 2 Water Meter	Where sub meters are fitted to allow individual water-consuming plant or building areas to be monitored such as cooling towers, car washes, catering areas, etc. If the building does not have any major water consuming plant this exemplar credit is not available. Each sub meter has a pulsed output to enable connection to a Building Management System (BMS) for the monitoring of water consumption. In addition to the above, for sites with multiple departments e.g. large health centres or acute hospitals, separate pulsed sub meters are fitted on the supply to the following areas where present: a. Staff and public areas b. Clinical areas and wards c. Letting areas: On the water supply to each tenant unit d. Laundries e. Main production kitchen f. Hydrotherapy pools g. Laboratories h. CSSD/HSDU, pathology, pharmacy, mortuary and any other major process water user.	1	0
Innovation	Mat 1 Materials Specification	One exemplary BREEAM credit can be awarded as follows: a. Where assessing four or more applicable building elements, the building achieves at least two points additional to the total points required to achieve maximum credits under the standard BREEAM requirements. b. Where assessing fewer than four applicable building elements, the building achieves at least one point additional to the total points required to achieve maximum credits under the standard BREEAM requirements.	1	0
Innovation	Mat 5 Responsible Sourcing of Materials	Where, in addition to the standard BREEAM requirements, 95% of the applicable materials, comprised within the applicable building elements, have been responsibly sourced.	1	1
Innovation	Wst 1 Construction Site Waste Management	Where non-hazardous construction waste generated by the building's development meets or exceeds the resource efficiency benchmark required to achieve three credits (as outlined in the guidance). Where at least 90% by weight (80% by volume) of non-hazardous construction waste and 95% of demolition waste by weight (85% by volume) (if applicable) generated by the build has been diverted from landfill and either: a. Reused on site (in-situ or for new applications) b. Reused on other sites c. Salvaged/reclaimed for reuse d. Returned to the supplier via a 'take-back' scheme e. Recovered from site by an approved waste management contractor and recycled. Where all key waste groups are identified for diversion from landfill at pre-construction stage SWMP.	1	1
Innovation	BREEAM Accredited Professional	Up to two credits are available for the comprehensive use of a BREEAM Accredited Professional (AP).	2	2
		Indicative Innovation (weighted) Section Score	6.00%	

BRE Global CFCS - Worksheet 1

Business Name:

BUSINESS UTILITIES

Over what period is the energy information applicable (1, 3 or 12 months)

	Unit	Units used
Electricity	kWh	
Natural Gas	kWh	
	therms	
	M3	
Gas Oil	kWh	
	tonnes	
	litres	
LPG	kWh	
	therms	
	litres	
Coal	kWh	
	tonnes	
Burning Oil (kerosene/paraffin)	kWh	
	tonnes	
	litres	
Water	M3	
	litres	

Worksheet Completed by:

Assessor Name: Assessor Number:

Date: Signed:

BRE Global CFCS - Worksheet 2

Business Name:

HOME OFFICE

How many bedrooms does your house have?	
How many days per week do you work from home?	
Over what period is the energy information applicable (1, 3 or 12 months)	

	Units	**Units used**
Electricity	kWh	
Natural Gas	kWh	
	therms	
	M3	
Gas Oil	kWh	
	tonnes	
	litres	
LPG	kWh	
	therms	
	litres	
Coal	kWh	
	tonnes	

Worksheet Completed by:

Assessor Name: Assessor Number:

Date: Signed:

BRE Global CFCS - Worksheet 3

Business Name:

BUSINESS TRANSPORT

Over what period is the energy information applicable (1, 3 or 12 months)

	Fuel / type	Unit	Units used
Freight transport	Petrol	litres	0
	Diesel	litres	0
	LPG	litres	0
	Compressed Natural Gas	kg	0
Car travel	Petrol	litres	0
		miles	0
	Diesel	litres	0
		miles	0
	LPG	litres	0
	Compressed Natural Gas	kg	0
	Hybrid (medium petrol)	miles	0
	Hybrid (large petrol)	miles	0
	Unknown fuel	miles	0
Motorcycle travel	Average engine size	miles	0
		km	0
Train travel		miles	0
		km	0
Bus travel		miles	0
		km	0
Air travel	Domestic	miles	0
		km	0
	Short haul	miles	0
		km	0
	Long haul	miles	0
		km	0

Worksheet Completed by:

Assessor Name:

Assessor Number:

Date:

Signed:

BRE Global CFCS - Worksheet 4

Business Name:

STAFF COMMUTE

Over what period is the energy information applicable (1, 3 or 12 months)

	Fuel / type	Unit	Units used
Car travel	Petrol	litres	
		miles	
	Diesel	litres	
		miles	
	LPG	litres	
	Compressed Natural Gas	kg	
	Hybrid (medium petrol)	miles	
	Hybrid (large petrol)	miles	
	Unknown fuel	miles	
Motorcycle travel	Average engine size	miles	
		km	
Train travel		miles	
		km	
Bus travel		miles	
		km	

Worksheet Completed by:

Assessor Name:

Assessor Number:

Date:

Signed:

BRE Global CFCS - Worksheet

Business Name:

GREENHOUSE GAS PROCESS EMISSIONS

Please note the units entered below MUST relate to the following period:	12 Months		
	Unit		Amount emitted
Methane	tonnes		
Nitrous Oxide	tonnes		
HFC - 125	tonnes		
HFC - 134	tonnes		
HFC - 134a	tonnes		
HFC - 143	tonnes		
HFC - 143a	tonnes		
HFC - 152a	tonnes		
HFC - 227ea	tonnes		
HFC - 23	tonnes		
HFC - 236fa	tonnes		
HFC - 245ca	tonnes		
HFC - 32	tonnes		
HFC - 41	tonnes		
HFC - 43 - 10mee	tonnes		
Perfluorobutane	tonnes		
Perfluoromethane	tonnes		
Perfluoropropane	tonnes		
Perfluoropentane	tonnes		
Perfluorocyclobutane	tonnes		
Perfluoroethane	tonnes		
Perfluorohexane	tonnes		
SF6	tonnes		

Worksheet Completed by:

Assessor Name: Assessor Number:

Date: Signed:

APPENDIX C
LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN V2.0 SCORECARD

LEED for New Construction v2.0
Registered Project Checklist

Project Name:
Project Address:

Rinker Yes	Rinker ?	Rinker No	Gerson Yes	Gerson ?	Gerson No		
9	0	0	2	2	10		**Sustainable Sites**
Y			Y			Prereq 1	**Erosion & Sedimentation Control**
1			1			Credit 1	**Site Selection**
					1	Credit 2	**Urban Redevelopment**
					1	Credit 3	**Brownfield Redevelopment**
1			1			Credit 4.1	**Alternative Transportation**, Public Transportation Access
1				1		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms
					1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations
1					1	Credit 4.4	**Alternative Transportation**, Parking Capacity
					1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space
1					1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint
1					1	Credit 6.1	**Stormwater Management**, Rate and Quantity
					1	Credit 6.2	**Stormwater Management**, Treatment
1					1	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof
1					1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof
1				1		Credit 8	**Light Pollution Reduction**

Rinker Yes	Rinker ?	Rinker No	Gerson Yes	Gerson ?	Gerson No	
4	0	0	0	2	3	**Water Efficiency**

Yes	?	No	Yes	?	No		
1				1		Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%
1				1		Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation
					1	Credit 2	**Innovative Wastewater Technologies**
1					1	Credit 3.1	**Water Use Reduction**, 20% Reduction
1					1	Credit 3.2	**Water Use Reduction**, 30% Reduction

Yes	?	No	Yes	?	No		
9	0	0	1	0	16		**Energy & Atmosphere**
Y			Y			Prereq 1	**Fundamental Building Systems Commissioning**
Y			Y			Prereq 2	**Minimum Energy Performance**
Y			Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**
9					10	Credit 1	**Optimize Energy Performance**
							20% New Buildings or 10% Existing Building Renovations
							30% New Buildings or 20% Existing Building Renovations
							40% New Buildings or 30% Existing Building Renovations
							50% New Buildings or 40% Existing Building Renovations
							60% New Buildings or 50% Existing Building Renovations
					1	Credit 2.1	**Renewable Energy**, 5%
					1	Credit 2.2	**Renewable Energy**, 10%
					1	Credit 2.3	**Renewable Energy**, 20%
					1	Credit 3	**Additional Commissioning**
			1			Credit 4	**Ozone Depletion**
					1	Credit 5	**Measurement & Verification**
					1	Credit 6	**Green Power**

Yes	?	No	Yes	?	No		
6	0	0	0	6	7		**Materials & Resources**
Y			Y			Prereq	**Storage & Collection of Recyclables**

Yes	?	No	Yes	?	No	Credit	Description
						1	
					1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell
					1	Credit 1.2	**Building Reuse**, Maintain 100% of Shell
					1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell
1					1	Credit 2.1	**Construction Waste Management**, Divert 50%
1					1	Credit 2.2	**Construction Waste Management**, Divert 75%
					1	Credit 3.1	**Resource Reuse**, Specify 5%
					1	Credit 3.2	**Resource Reuse**, Specify 10%
1				1		Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)
1				1		Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)
1				1		Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally
				1		Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally
				1		Credit 6	**Rapidly Renewable Materials**
1				1		Credit 7	**Certified Wood**

Yes	?	No	Yes	?	No		
8	0	0	0	4	11		**Indoor Environmental Quality**
Y			Y			Prereq 1	**Minimum IAQ Performance**
Y			Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**
					1	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**
				1		Credit 2	**Increase Ventilation Effectiveness**
1					1	Credit 3.1	**Construction IAQ Management Plan**, During Construction
					1	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy
1					1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants
1					1	Credit 4.2	**Low-Emitting Materials**, Paints
1					1	Credit 4.3	**Low-Emitting Materials**, Carpet
					1	Credit 4.4	**Low-Emitting Materials**, Composite Wood
					1	Credit 5	**Indoor Chemical & Pollutant Source Control**

1					1	Credit 6.1	**Controllability of Systems**, Perimeter
					1	Credit 6.2	**Controllability of Systems**, Non-Perimeter
1				1		Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992
					1	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System
1				1		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces
1				1		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces
Yes	?	No	Yes	?	No		
3	**0**	**0**	**0**	**0**	**5**	**Innovation & Design Process**	
1					1	Credit 1.1	**Innovation in Design**: Provide Specific Title
1					1	Credit 1.2	**Innovation in Design**: Provide Specific Title
					1	Credit 1.3	**Innovation in Design**: Provide Specific Title
					1	Credit 1.4	**Innovation in Design**: Provide Specific Title
1					1	Credit 2	**LEED™ Accredited Professional**
Yes	?	No	Yes	?	No		
39	**0**	**0**	**3**	**14**	**52**	**Project Totals (pre-certification estimates)**	

Certified: 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 points

APPENDIX D
COMPREHENSIVE ASSESSMENT SYSTEM FOR BUILDING ENVIRONMENTAL EFFICIENCY SCORECARD

CASBEE® for New Construction | Assessment result

■Manual : CASBEE for New Construction (2008 Edition) ■software : CASBEE-NCe_2008(v.2.0)

1-1 Building Outline

Building Name	Rinker	Number of Floors	3
Location	Gainesville, FL	Structure	S
Area / Zone	Commercial Area	Occupancy	250 persons
Climate Zone	Area Category VI	Annual Occupancy	2,000 hrs/yr
Building Type	Schools,	Assessment phase	Completion stage
Completion	4-Aug-10 Completion	Assessment date	8-Jul-08
Site Area	4,683 m^2	Assessor	Mark Russell
Construction Area	1,624 m^2	Date of approval	10-Jul-08
Gross Floor Area	4,322 m^2	Approved by	XXXX

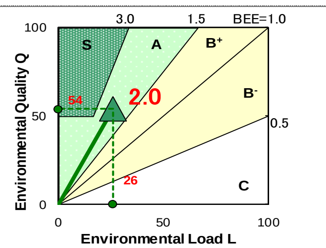
1-2 Appearance

Appearance, views, etc.

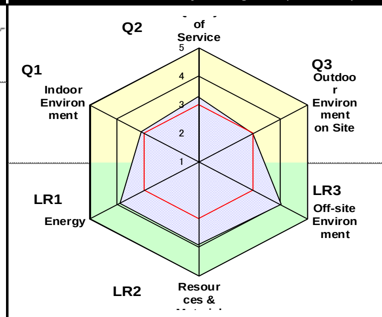
2-1 Building Environmental Efficiency (tank & chart)

BEE = 2.0 ★★★★

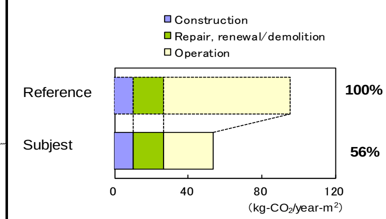
S: ★★★★★ A: ★★★★ B+: ★★★ B-: ★★ C: ★



2-2 Assessment results of Major categories (rader chart)



2-3 Lifecycle CO2 (Global warming impact chart)

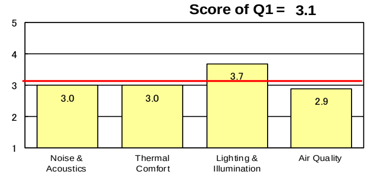


This chart indicates rough estimate of lifecycle CO2 emission from subject building compared with that from reference building.

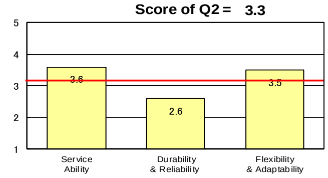
2-4 Assessment results of Medium-level categories (bar chart)

Q Environmental Quality — Score of Q= 3.1

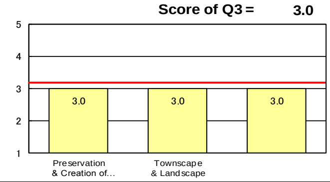
Q1 Indoor Environment — Score of Q1 = 3.1



Q2 Quality of Service — Score of Q2 = 3.3

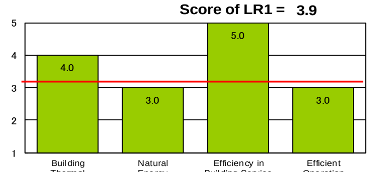


Q3 Outdoor Environment on Site — Score of Q3 = 3.0

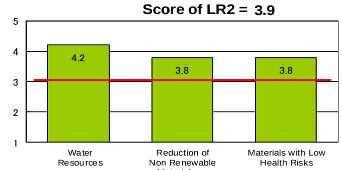


LR Environmental Load Reduction — Score of LR= 3.9

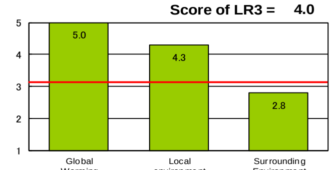
LR1 Energy — Score of LR1 = 3.9



LR2 Resources & Materials — Score of LR2 = 3.9



LR3 Off-site Environment — Score of LR3 = 4.0



3 Design considerations

General

Describe briefly comprehensive concept of environmental design of the building.

Other

Describe briefly considerations for other than 6 categories above that is not assessed in CASBEE-NC, such as recycling activities at constriction site and preservation of historic buildings.

Q1 Indoor Environment

Describe briefly considerations for Q1 Indoor Environment of the building.

Q2 Quality of Service

Describe briefly considerations for Q2 Quality of Service of the building.

Q3 Outdoor Environment on Site

Describe briefly considerations for Q3 Outdoor Environment on Site of the building.

LR1 Energy

Describe briefly considerations for LR1 Energy of the building.

LR2 Resources & Materials

Describe briefly considerations for LR2 Resources & Materials of the building.

LR3 Off-site Environment

Describe briefly considerations for LR3 Off-site Environment of the building.

CASBEE® for New Construction

Assessment Software

Version	CASBEE-NCe_2008(v.2.0)
■ **Assessment Manual :**	CASBEE for New Construction (2008 Edition)

1) Summary input

[1] Summary of the designated area

■Building Name	Rinker	
■Location / Climate	Gainesville, FL	Area Category VI
■Area / Zone	Commercial Area	
■Completion(Scheduled / Completion)	Aug-10	Completion
■Site Area	4683.00 m^2	
■Construction Area	1624.00 m^2	
■Gross Floor Area	4,322.00 m^2	
■Building Type ※	Schools	
(Building Application Name)	Schools,	
■Number of Floors	3	
■Structure	S	
■Occupancy	250 Occupants(assumed)	
■Annual Occupancy	2,000 hrs /yr(assumed)	

[2] Implimentation of Assessment

■Assessment date	8-Jul-08	Completion stage
■Assessor	Mark Russell	
■Date of confirmation	10-Jul-08	
■Confirmed by	XXXX	
■LCCO2 calculation	Standard calculation	--> Input LCCO2 Calculation Conditions Sheet (standard calculation)

2) Entry for individual building type

[1] Floor area of each building type

Offices		m^2
Schools	4322.00	m^2
Retailers		m^2
Restaurants		m^2
Halls		m^2
Factory		m^2
Hospital		m^2
Hotel		m^2
Apartments		m^2

[2] Ratio of Residential & Accommodation Section Enter rounded values for hospitals, hotels and apartments.

■ Proportion of total floor area of a hospital used for sickrooms.
■ Proportion of total floor area of a hotel used for guest rooms.
■ Proportion of total floor area of an apartment used for residences.

3) Display of each sheet

Score Sheet	●Score	
Assessment Result Sheet	●Result	●LCCO2 calculation
LCCO2 Calculation Conditions Sheet	●Standard calculation	●Individual calculation

※**Building Type**	**Types included**
Offices	Offices, government buildings, libraries, museum, post office etc.
Schools	Elementary schools, junior high schools, high schools, universities, technical colleges, higher vocational schools, and other school types.
Retailers	Department stores, supermarket etc.
Restaurants	Restaurant, canteens, café etc.
Halls	Auditoria, meeting halls, pavilions, bowling lanes, gymnasia, theaters, pachinko parlors etc.
Factories	Plants, garages, storage plants, pavilion, wholesale market etc.
Hospitals	Hospitals, homes for the elderly, welfare homes for the handicapped etc.
Hotels	Hotels, inns etc.
Apartments	Condominiums (detached houses are excluded)

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enter figures and comments.

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Score Sheet			Completion stage					
Concerned categories				Entire Building and Common Properties		Residential and Accomodation sections		**Total**
				Score	weighting coefficients	**Score**	weighting coefficients	
Q Environmental Quality of the building								**3.1**
Q1 Indoor Environment					**0.40**			**3.1**
1	**Noise & Acoustics**			**3.0**	0.15	**-**	-	**3.0**
	1.1	Noise		**3.0**	0.40	**-**	-	
		1	Background noise level	3.0	0.50	3.0	-	
		2	Equipment noise	3.0	0.50	-	-	
	1.2	Sound Insulation		**3.0**	0.40	**-**	-	
		1	Sound Insulation of Openings	3.0	0.30	3.0	-	
		2	Sound Insulation of Partition Walls	3.0	0.30	3.0	-	
		3	Sound Insulation Performance of Floor Slabs (light-weight impact source)	3.0	0.20	3.0	-	
		4	Sound Insulation Performance of Floor Slabs (heavy-weight impact source)	3.0	0.20	3.0	-	
	1.3	Sound Absorption		**3.0**	0.20	**3.0**	-	
2	**Thermal Comfort**			**3.0**	0.35	**-**	-	**3.0**
	2.1	Room Temperature Control		**3.0**	0.50	**-**	-	

		1	Room Temperature Setting	3.0	0.30	3.0	-	
		2	Variable Loads and Following-up Control	3.0	0.20	-	-	
		3	Perimeter Performance	3.0	0.20	3.0	-	
		4	Zoned Control	3.0	-	-	-	
		5	Temperature and Humidity Control	3.0	0.10	3.0	-	
		6	Individual Control	-	-	3.0	-	
		7	Allowance for After-hours Air Conditioning	3.0	0.20	-	-	
		8	Monitoring Systems	3.0	-	-	-	
	2.2	Humidity Control		**3.0**	0.20	**3.0**	-	
	2.3	Type of Air Conditioning System		**3.0**	0.30	**3.0**	-	
3	**Lighting & Illumination**			**3.7**	0.25	**-**	-	**3.7**
	3.1	Daylighting		**3.0**	0.30	**-**	-	
		1	Daylight Factor	3.0	0.60	3.0	-	
		2	Openings by Orientation	-	-	3.0	-	
		3	Daylight Devices	3.0	0.40	3.0	-	
	3.2	Anti-glare Measures		**3.6**	0.30	**-**	-	
		1	Glare from Light Fixtures	3.0	0.40	3.0	-	
		2	Daylight Control	4.0	0.60	3.0	-	
	3.3	Illuminance Level		**3.6**	0.15	**-**	-	
		1	Illuminanc e	3.0	0.70	3.0	-	
		2	Uniformity of Illuminance	5.0	0.30	3.0	-	
	3.4	Lighting Controllability		**5.0**	0.25	3.0	-	
4	**Air Quality**			**2.9**	0.25	**-**	-	**2.9**
	4.1	Source Control		**2.6**	0.50	**-**	-	
		1	Chemical Pollutants	3.0	0.33	3.0	-	

		2	Asbestos	-	-	-	-		
		3	Mites, Mold etc	1.0	0.33	3.0	-		
		4	Legionella	4.0	0.33	3.0	-		
	4.2		Ventilation	**4.0**	0.30	**-**	-		
		1	Ventilation Rate	4.0	0.25	3.0	-		
		2	Natural Ventilation Performance	4.0	0.25	3.0	-		
		3	Consideration for Outside Air Intake	5.0	0.25	3.0	-		
		4	Air Supply Planning	3.0	0.25	3.0	-		
	4.3		Operation Plan	**2.0**	0.20	**-**	-		
		1	CO2 Monitoring	1.0	0.50	-	-		
		2	Control of Smoking	3.0	0.50	-	-		
Q2 Quality of Service				–	**0.30**	**-**	**-**	**3.3**	
1	**Service Ability**			**3.6**	0.40	**-**	-	**3.6**	
	1.1		Functionality & Usability	**3.0**	0.40	**-**	-		
		1	Provision of Space & Storage	3.0	-	3.0	-		
		2	Use of Advanced Information System	3.0	-	3.0	-		
		3	Barrier-free Planning	3.0	1.00	-	-		
	1.2		Amenity	**4.5**	0.30	**-**	-		
		1	Perceived Spaciousness & Access to View	5.0	0.50	3.0	-		
		2	Space for Refreshment	5.0	-	-	-		
		3	Décor Planning	4.0	0.50	-	-		
	1.3		Maintenance Management	**3.5**	0.30	**-**	-		
		1	Design Which Considers Maintenance Management	3.0	0.50	-	-		
		2	Securing Maintenance Management Functions	4.0	0.50	-	-		
2	**Durability & Reliability**			**2.6**	0.31	**-**	-	**2.6**	

	2.1		Earthquake Resistance	**3.0**	0.48	**-**	-	
		1	Earthquake-resistance	3.0	0.80	-	-	
		2	Seismic Isolation & Vibration Damping Systems	3.0	0.20	-	-	
	2.2		Service Life of Components	**3.0**	0.33	**-**	-	
		1	Service Life of Structural Frame Materials	3.0	0.23	-	-	
		2	Necessary Refurbishment Interval for Exterior Finishes	3.0	0.23	-	-	
		3	Necessary Renewal Interval for Main Interior Finishes	3.0	0.09	-	-	
		4	Necessary Replacement Interval for Air Conditioning and Ventilation Ducts	3.0	0.08	-	-	
		5	Necessary Renewal Interval for HVAC and Water Supply and Drainage Pipes 99	3.0	0.15	-	-	
		6	Necessary Renewal Interval for Major Equipment and Services	3.0	0.23	-	-	
	2.3		Appropriate renewal	**-**	-	**-**	-	
	2.4		Reliability	**1.4**	0.19	**-**	-	
		1	HVAC System	1.0	0.20	-	-	
		2	Water Supply & Drainage	3.0	0.20	-	-	
		3	Electrical Equipment	1.0	0.20	-	-	
		4	Support Method of Machines & Ducts	1.0	0.20	-	-	
		5	Communications & IT Equipment	1.0	0.20	-	-	
3	**Flexibility & Adaptability**			**3.5**	0.29	**-**	-	**3.5**
	3.1		Spatial Margin	**3.0**	0.31	**-**	-	
		1	Allowance for Floor-to-floor Height	3.0	0.60	3.0	-	
		2	Adaptability of Floor Layout	3.0	0.40	3.0	-	
	3.2		Floor Load Margin	**3.0**	0.31	**3.0**	-	
	3.3		Adaptability of Facilities	**4.5**	0.38	**-**	-	
		1	Ease of Air Conditioning Duct Renewal	5.0	0.17	-	-	
		2	Ease of Water Supply and Drain Pipe Renewal	5.0	0.17	-	-	
		3	Ease of Electrical Wiring Renewal	5.0	0.11	-	-	

	4	Ease of Communications Cable Renewal	5.0	0.11	-	-	
	5	Ease of Equipment Renewal	5.0	0.22	-	-	
	6	Provision of Backup Space	3.0	0.22	-	-	
Q3 Outdoor Environment on Site			–	**0.30**	**-**	**-**	**3.0**
1		**Preservation & Creation of Biotope**	**3.0**	0.30	**-**	-	**3.0**
2		**Townscape & Landscape**	**3.0**	0.40	**-**	-	**3.0**
3		**Local Characteristics & Outdoor Amenity**	**3.0**	0.30	**-**	-	**3.0**
	3.1	Attention to Local Charcter & Improvement of Comfort	**3.0**	0.50	**-**	-	
	3.2	Improvement of the Thermal Environment on Site	**3.0**	0.50	**-**	-	
LR Environmental Load Reduction of the building			–	-	-	-	**3.9**
LR1 Energy			–	**0.40**	**-**	**-**	**3.9**
1		**Building Thermal Load**	**4.0**	0.30	**-**	-	**4.0**
2		**Natural Energy Utilization**	**3.0**	0.20	**-**	-	**3.0**
	2.1	Dirct Use of Natural Energy	-	-	-	-	
	2.2	Converted Use of Renewable Energy	3.0	-	-	-	
3		**Efficiency in Building Service System**	**5.0**	0.30	**-**	-	**5.0**
4		**Efficient Operation**	**3.0**	0.20	**-**	-	**3.0**
	4.1	Monitoring	**3.0**	0.50	**-**	-	
	4.2	Operation & Management System	**3.0**	0.50	**-**	-	
LR2 Resources & Materials			–	**0.30**	**-**	**-**	**3.9**
1		**Water Resources**	**4.2**	0.15	**-**	-	**4.2**
	1.1	Water Saving	**4.0**	0.40	**-**	-	
	1.2	Rainwater & Gray Water	**4.3**	0.60	**-**	-	
	1	Rainwater Use System	5.0	0.67	-	-	
	2	Gray Water Reuse System	3.0	0.33	-	-	
2		**Reducing Usage of Non-renewable Resources**	**3.8**	0.63	**-**	-	**3.8**
	2.1	Reducing Usage of Materials	3.0	0.07	-	-	
	2.2	Continuing Use of Existing Building Skeleton etc	3.0	0.24	-	-	

		2.3	Use of Recycled Materials as Structural Frame Materials	4.0	0.20	-	-	
		2.4	Use of Recycled Materials as Non-structural Materials	4.0	0.20	-	-	
		2.5	Timber from Sustainable Forestry	3.0	0.05	-	-	
		2.6	Reusability of Components and Materials	5.0	0.24	-	-	
3	**Avoiding the Use of Materials with Pollutant Content**			**3.8**	0.22	**-**	-	**3.8**
		3.1	Use of Materials without Harmful Substances	5.0	0.32	-	-	
		3.2	Avoidance of CFCs and Halons	**3.3**	0.68	**-**	-	
		1	Fire Retardant	4.0	0.33	-	-	
		2	Insulation Materials	3.0	0.33	-	-	
		3	Refrigerants	3.0	0.33	-	-	
LR3 Off-site Environment				_	**0.30**	**-**	-	**4.0**
1	**Consideration of Global Warming**			**5.0**	0.33	**-**	-	**5.0**
2	**Consideration of Local Environment**			**4.3**	0.33	**-**	-	**4.3**
		2.1	Air Pollution	**5.0**	0.25	**-**	-	
		2.2	Heat Island Effect	**5.0**	0.50	**-**	-	
		2.3	Load on Local Infrastructure	**2.5**	0.25	-	-	
		1	Reduction of Rainwater Discharge Loads	3.0	0.25	-	-	
		2	Sewage Load Suppression	3.0	0.25	**-**	-	
		3	Traffic Load Control	2.0	0.25	**-**	-	
		4	Waste Treatment Loads	2.0	0.25	**-**	-	
3	**Consideration of Surrounding Environment**			**2.8**	0.33	**-**	-	**2.8**
		3.1	Noise, Vibration & Odor	**3.0**	0.40	**-**	-	

		1	Noise	3.0	1.00	-	-	
		2	Vibration	-	-	-	-	
		3	Odor	-	-	-	-	
	3.2		Wind Damage & Sunlight Obstruction	**1.9**	0.40	-	-	
		1	Restriction of Wind Damage	1.0	0.70		-	
		2	Restriction of sunlight obstruction	4.0	0.30		-	
	3.3		Light Pollution	**4.4**	0.20	-	-	
		1	Outdoor Illumination and Light that Spills from Interiors	5.0	0.70		-	
		2	Measures for Reflected Solar Glare from Building Walls	3.0	0.30		-	

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■Manual : CASBEE for New Construction (2008 Edition)

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Life Cycle CO2 Calculation Sheet （For Standard calculation）

1. CO2 Emissions Related to Construction

1-1. Conversion of Assessment Results to CO2 emission

		Ratio of Total floor area	Subject Level 3 (kg-CO_2/m^2-yr)	Level 4	Level 5	Score	CO2 Emissions (kg-CO_2/m^2-yr)	Reference Score	Reference CO2 Emissions (kg-CO_2/m^2-yr)
Q2/2.2.1 Service Life of Structural Frame Materials	Offices	0.00	13.61	13.61	13.61	3.0	13.61	3.0	13.61
	Schools	1.00	10.24	10.24	10.24	3.0	10.24	3.0	10.24
	Retailers	0.00	16.13	16.13	16.13	3.0	16.13	3.0	16.13
	Restaurants	0.00	16.13	16.13	16.13	3.0	16.13	3.0	16.13
	Halls	0.00	10.96	10.96	10.96	3.0	10.96	3.0	10.96
	Factories	0.00	18.18	18.18	18.18	3.0	18.18	3.0	18.18
	Hospitals	0.00	10.39	10.39	10.39	3.0	10.39	3.0	10.39
	Hotels	0.00	10.92	10.92	10.92	3.0	10.92	3.0	10.92
	Apartments	0.00	15.93	8.06	5.47	3.0	15.93	3.0	15.93

Structure	S		
LR2/2.2 Continuing Use of Existing Building Skeleton etc.	0%		0%
LR2/2.3 Use of Recycled Materials as Structural Frame Materials（Blast furnace cement (concrete)）	0%		0%

1-2. Subtotal 10.24 10.24

2. CO2 Emissions Related to Retated to Repair, Renewal and Demolition

2-1. Conversion of Assessment Results to CO2 emission

		Ratio of Total floor area	Level 3	Level 4	Level 5	Score	CO2 Emissions	Score	CO2 Emissions
					kg-CO_2/m^2-yr		kg-CO_2/m^2-yr		kg-CO_2/m^2-yr
Q2/2.2.1 Service Life of Structural Frame Materials	Offices	0.00	20.23	20.23	20.23	3.0	20.23	3.0	20.23
	Schools	1.00	16.68	16.68	16.68	3.0	16.68	3.0	16.68
	Retailers	0.00	12.20	12.20	12.20	3.0	12.20	3.0	12.20
	Restaurants	0.00	12.20	12.20	12.20	3.0	12.20	3.0	12.20
	Halls	0.00	17.39	17.39	17.39	3.0	17.39	3.0	17.39
	Factories	0.00	13.62	13.62	13.62	3.0	13.62	3.0	13.62
	Hospitals	0.00	20.24	20.24	20.24	3.0	20.24	3.0	20.24
	Hotels	0.00	18.1	18.1	18.1	3.0	18.1	3.0	18.1

		1	1	1		1		1
Apartments	0.00	13.58	14.94	16.22	3.0	13.58	3.0	13.58
2-2. Subtotal						16.68		16.68

3. CO2 Emissions Related to Energy during Operation	kg-CO_2/m^2-yr	kg-CO_2/m^2-yr
	26.55	68.53
4. Calculation of Life Cycle CO2 （Standard calculation）	kg-CO_2/m^2-yr	kg-CO_2/m^2-yr
	CO2 Emissions	CO2 Emissions
Construction	10.24	10.24
Repair, Renewal and Demolition	16.68	16.68
Operation	26.55	68.53
Total	**53.47**	**95.45**

Q1 Indoor environment

1. Noise & Acoustics

1.1 Noise

1.1.1 Background noise level

	dB(A)	Weighting coefficients (default)=	0.50	dB(A)	Weighting coefficients (default)=	0.00

Level 3.0	Entire building and common properties				Level 3.0	Residential and Accommodation Sections	
	Off, Hsp(Waiting Room), Htl, Apt, Fct	Sch, Hsp(Examining Room)	Rtl, Rst	Hal		Hsp	Htl, Apt
Level 1	50< [Background noise level]	45< [Background noise level]	55< [Background noise level]	40< [Background noise level]	**Level 1**	50< [Background noise level]	45< [Background noise level]
Level 2	47< [Background noise level] =<50	42< [Background noise level] =<45	52< [Background noise level] =<55	37< [Background noise level] =<40	**Level 2**	47< [Background noise level] =<50	42< [Background noise level] =<45
■Level 3	43< [Background noise level] =<47	38< [Background noise level] =<42	48< [Background noise level] =<52	33< [Background noise level] =<37	**■Level 3**	43< [Background noise level] =<47	38< [Background noise level] =<42
Level 4	40< [Background noise level] =<43	35< [Background noise level] =<38	45< [Background noise level] =<48	30< [Background noise level] =<33	**Level 4**	40< [Background noise level] =<43	35< [Background noise level] =<38
Level 5	[Background noise level] =<40	[Background noise level] =<35	[Background noise level] =<45	[Background noise level] =<30	**Level 5**	[Background noise level] =<40	[Background noise level] =<35

Background noise Allowable interior noise levels

dB(A)	20	25	30	35	40	45	50	55	60
NC-NR	10~15	15~20	20~25	25~30	30~35	35~40	40~45	45~50	50~55
Intrusiveness	Silent———			———————————Very Quiet———————————		—Not significantly noticeable——————	Perceived noise—	———————Noise cannot be ignored	
Impact on conversation				A whispering voice is audible from 5m away		Possible from 10m apart Telephone use (normal) ————————	Possible from 3m apart Telephone use (bearable) ————————		Loud conversation (3m) Telephone use (unbearable)
Studios	Silent room	Studio for newsreading etc.	Radio studio	Television studios	Mixing room	General offices			
Venues and halls		Music hall		Theater (medium)	Stage theaters	Movie theater, planetarium	Hotel lobbies		
Hospitals		Hearing test room	Special sickrooms	Sickrooms	Examining room	Laboratories	Waiting rooms		
Hotel and residential				Reading rooms	Bedrooms	Banquet halls	Lobbies		
General offices				Large meeting rooms	Reception rooms	Meeting rooms	General offices		Typing and accounting rooms
Public buildings				Auditorium	Museums	Library	Auditorium/ gymnasium	Indoor sports facilities	
Schools and churches				Music classroom	Chapels		Research rooms and classrooms	Corridors	
Commercial buildings					Music cafes Jewelers and art shops	Book shops	General stores Banks and restaurants	Canteens	

1.1.2 Equipment noise

	Weighting coefficients (default)= 0.50			Weighting coefficients (default)= 0.00
Level 3.0	Entire building and common properties	**Level**	Residential and Accommodation Sections	
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct		Hsp, Htl	Apt
Level 1	No noise countermeasures. (No countermeasures at all among the Efforts to be evaluated)	**Level 1**	No noise countermeasures. (No countermeasures at all among the Efforts to be evaluated)	No noise countermeasures. (No countermeasures at all among the Efforts to be evaluated)
Level 2	Some measures taken. (Two or more noise countermeasures used from among the Efforts to be evaluated).	**Level 2**	Some measures taken. (Two or more noise countermeasures used from among the Efforts to be evaluated).	
■Level 3	Noise countermeasures used. (Four or more noise countermeasures used from among the Efforts to be evaluated).	**Level 3**	Noise countermeasures used. (Four or more noise countermeasures used from among the Efforts to be evaluated).	Noise countermeasures used. (Two or more noise countermeasures used from among the Efforts to be evaluated).
Level 4	Countermeasures at a moderately high level. (Six or more noise countermeasures used from among the Efforts to be evaluated).	**Level 4**	Countermeasures at a moderately high level. (Six or more noise countermeasures used from among the Efforts to be evaluated).	
Level 5	Countermeasures at an advanced level. (All noise countermeasures used from among the Efforts to be evaluated).	**Level 5**	Countermeasures at an advanced level. (All noise countermeasures used from among the Efforts to be evaluated).	Countermeasures at an advanced level. (All noise countermeasures used from among the Efforts to be evaluated).

A1. Except Apartments, efforts to be evaluated (exp.) for Entire building and common properties

Level 3.0	<-- Direct input	
Level 3.0	Entire building and common properties	
	Types of equipment noise	Examples of countermeasures
	Vents and intakes	Low-noise vents, low-noise intakes, positions, air speed and volume, etc.
	Interior air conditioning equipment	Noise prevention covers, positions etc.
	Noise from the machine room (penetrating noise)	Noise prevention covers, sound absorption and Sound insulation for the machine room, position etc.
yes	As above (noise transmitted through solids)	Anti-vibration platform, anti-vibration rubber elements, etc.
yes	Noise from ducts and pipes (penetrating noise)	Sound absorber ducts, sound absorber elbows, sound absorber boxes, sound insulating pipe cladding, position etc.
yes	As above (noise transmitted through solids)	Anti-vibration suspension or supports, flexible joints, anti-vibration treatment of penetrating parts.
yes	(Exterior) Noise from cooling towers	Baffles, anti-vibration supports, position etc.
yes	(Exterior) Noise from intakes and vents	Position, appropriate air volume and speed, etc.

B For Apartments, efforts to be evaluated (exp.)

Level 2.0	<-- Direct input	
Level 3.0	Floor area for Residential and Accommodation Sections (Apt) m²	
	Types of equipment noise	Examples of countermeasures
yes	Water supply and drainage noises from toilets, bathrooms etc.	Anti-noise pipe cladding, anti-vibration rubber support fittings, positioning, etc.
	Water hammer	Use of appropriate water pressure, selection of preventive fixtures, etc.
yes	Noise from air conditioning room units	Selection of low-noise equipment etc.
	Noise from air conditioning external units	Anti-vibration rubber supports, anti-vibration mats, selection of low-noise equipment types, etc.
yes	Ventilation	Selection of low-noise equipment etc.

1.2 Sound Insulation

1.2.1 Sound Insulation of Openings

	Weighting coefficients (default)= 0.30			Weighting coefficients (default)= 0.00	
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design	Execution Design and Construction Completion		Preliminary Design	Execution Design and Construction Completion
	Off, Sch, Rst, Hsp, Htl, Fct, Apt	Off, Sch, Rst, Hsp, Htl, Fct, Apt		Hsp, Htl, Apt	Hsp, Htl, Apt
Level 1	Noise from ordinary traffic causes annoyance	Less than T-1	**Level 1**	Noise from ordinary traffic causes annoyance.	Less than T-1
Level 2		(No corresponding level)	**Level 2**		(No corresponding level)
■Level 3	Noise from ordinary traffic does not cause annoyance.	T-1	**■Level 3**	Noise from ordinary traffic does not cause annoyance.	T-1
Level 4		(No corresponding level)	**Level 4**		(No corresponding level)
Level 5	Noise from loud means of transport, such as trunk roads and aircraft, does not cause annoyance.	T-2 or more	**Level 5**	Noise from loud means of transport, such as trunk roads and aircraft, does not cause annoyance.	T-2 or more

1.2.2 Sound Insulation of Partition Walls

	Weighting coefficients (default)= 0.30			Weighting coefficients (default)= 0.00		
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections		
	Preliminary Design			Preliminary Design		
	Off, Sch, Rst, Fct	Hsp(Examining Room)		Hsp	Htl	Apt

Level 1	People's ordinary voices cause annoyance.	The content of conversation etc. can be understood.	**Level 1**	The content of TV, radio and conversation can be understood.	Ordinary sounds such as TV, radio and conversation can be clearly heard.	Activities in the next home can be clearly heard.
Level 2			**Level 2**			
Level 3	People's ordinary voices do not cause annoyance.	The sounds of conversation and general sounds can be heard at low volume.	**Level 3**	The sounds of TV, radio and conversation can be heard at low volume.	Ordinary sounds such as TV, radio and conversation can barely be heard faintly.	Activities in the next home can be heard but are not intrusive.
Level 4			**Level 4**			
Level 5	People's ordinary voices are almost inaudible.	The sounds of conversation and general sounds can barely be heard.	**Level 5**	The sounds of TV, radio and conversation can barely be heard.	Ordinary sounds such as TV, radio and conversation cannot normally be heard.	No sounds from the next home.
	Execution Design and Construction Completion			Execution Design and Construction Completion		
	Off, Sch, Rst, Fct	Hsp(Examining Room)		Hsp	Htl, Apt	
Level 1	Less than Dr-30	Less than Dr-35	**Level 1**	Less than Dr-35	Less than Dr-40	
Level 2	Dr-30	Dr-35	**Level 2**	Dr-35	Dr-40	
■Level 3	Dr-35	Dr-40	**■Level 3**	Dr-40	Dr-45	
Level 4	Dr-40	Dr-45	**Level 4**	Dr-45	Dr-50	
Level 5	Dr-45 or more	Dr-50 or better	**Level 5**	Dr-50 or better	Dr-55 or better	

1.2.3 Sound Insulation Performance of Floor Slabs (light-weight impact source)

	Weighting coefficients (default)= 0.20				Weighting coefficients (default)= 0.00
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design	Execution Design and Construction Completion		Preliminary Design	Execution Design and Construction Completion
	Sch	Sch		Hsp, Htl, Apt	Hsp, Htl, Apt
Level 1	Noise of chair movement and falling objects is intrusive.	Worse than Lr-65	**Level 1**	Noise of chair movement and falling objects casues considerable annoyanace.	Worse than Lr-55
Level 2		Lr-65	**Level 2**		Lr-55
■Level 3	Noise of chair movement and falling objects causes annoyance.	Lr-60	**■Level 3**	Noise of chair movement and falling objects is audible but quiet.	Lr-50
Level 4		Lr-55	**Level 4**		Lr-45
Level 5	Noise of chair movement and falling objects is just audible.	Lr-50 or better	**Level 5**	Noise of chair movement and falling objects is almost inaudible.	Lr-40 or better

1.2.4 Sound Insulation Performance of Floor Slabs (heavy-weight impact source)

	Weighting coefficients (default)= 0.20				Weighting coefficients (default)= 0.00
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design	Execution Design and Construction Completion		Preliminary Design	Execution Design and Construction Completion
	Sch	Sch		Hsp, Htl, Apt	Hsp, Htl, Apt
Level 1	The noise of people jumping and running causes considerable annoyance. (Worse than Lr-65)	Worse than Lr-65	**Level 1**	The noise of people jumping and running causes annoyance. (Worse than Lr-60)	Worse than Lr-60

Level 2	(Lr-65)	Lr-65	**Level 2**	(Lr-60)	Lr-60
■Level 3	The noise of people jumping and running causes considerably audible (Lr-60)	Lr-60	**■Lev el 3**	The noise of people jumping and running is audible.(Lr-55)	Lr-55
Level 4		Lr-55	**Level 4**		Lr-50
Level 5	The noise of people jumping and running is audible but quiet.	Lr-50 or better	**Level 5**	The noise of people jumping and running is audible but rarely noticed.	Lr-45 or better

1.3 Sound Absorption

	Weighting coefficients (default)=	0.20		Weighting coefficients (default)=	0.00
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design	Execution Design and Construction Completion		Preliminary Design	Execution Design and Construction Completion
	Off, Sch, Rtl, Rst, Hsp, Htl, Fct, Apt	Off, Sch, Rtl, Rst, Hsp, Htl, Fct, Apt		Hsp, Htl, Apt	Hsp, Htl, Apt
Level 1	Sound absorbent materials are not used.		**Level 1**	Sound absorbent materials are not used.	
Level 2			**Level 2**		
■Level 3	Sound absorbent materials are in either the walls, floor or ceiling.		**■Level 3**	Sound absorbent materials are in either the walls, floor or ceiling.	
Level 4			**Level 4**		
Level 5	Sound absorbent materials are in the walls, floor and ceiling.		**Level 5**	Sound absorbent materials are in the walls, floor and ceiling.	

2. Thermal Comfort

2.1 Room Temperature Control

2.1.1 Room Temperature Setting

	Weighting coefficients (default)=			0.30		Weighting coefficients (default)=	0.00
Level 3.0	Entire building and common properties				**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design					Preliminary Design	
	Off, Htl, Fct, Apt, Hsp(Waiting Room)	Hsp(Examining Room)	Sch	Rtl, Rst, Hal		Hsp, Htl	Apt

Level 1	Temperature settings of 20^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	Temperature settings of 21^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	Temperature settings of 10^{o}C or more in winter and 30^{o}C pr less in summer, which require tolerance of some discomfort	Temperature settings of 18^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	**Level 1**	Temperature settings of 20^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	Setting to 18^{o}C in winter and 28^{o}C in summer are forced in each room.
Level 2					**Level 2**		
Level 3	Ordinary setting of 22^{o}C in winter and 26oC in summer.	Ordinary setting of 23^{o}C in winter and 26^{o}C in summer.	Ordinary setting of 18 - 20^{o}C in winter and 25 - 28^{o}C in summer.	Ordinary setting of 20^{o}C in winter and 26^{o}C in summer.	**Level 3**	Ordinary setting of 22^{o}C in winter and 26^{o}C in summer.	Ordinary setting of 22^{o}C in winter and 26^{o}C in summer in each room.
Level 4					**Level 4**		
Level 5	By referring the ASHRAE Comfortable Room Temperature Range and the POEM-O, it is set ranges of 22~24^{o}C in winter and 24~26oC in summer.			By referring the ASHRAE Comfortable Room Temperature Range and the POEM-O, it is set ranges of 20~22^{o}C in winter and 24~26^{o}C in summer.	**Level 5**	By referring the ASHRAE Comfortable Room Temperature Range and the POEM-O, it is set ranges of 22~24^{o}C in winter and 24~26^{o}C in summer.	Setting ranges of 22 - 24^{o}C in winter and 24 - 26^{o}C in summer in each room.

	Execution Design and Construction Completion					Execution Design and Construction Completion	
	Off, Htl, Fct, Apt, Hsp(Waiting Room)	Hsp(Examining Room)	Sch	Rtl, Rst, Hal		Hsp, Htl	Apt
Level 1	The minimum equipment capacity is provided to achieve temperatures of 20^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	The minimum equipment capacity is provided to achieve temperatures of 21^{o}C in winter and 28^{o}C in summer, which requires tolerance of some discomfort.	The minimum equipment capacity is provided to achieve temperatures of 10^{o}C or more in winter and 28^{o}C ore less in summer, which require tolerance of some discomfort	The minimum equipment capacity is provided to achieve temperatures of 18^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort	**Level 1**	The minimum equipment capacity is provided to achieve temperatures of 20^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.	The minimum equipment capacity is provided to achieve temperatures of 18^{o}C in winter and 28^{o}C in summer, which require tolerance of some discomfort.
Level 2					**Level 2**		
■Level 3	Equipment capacity is provided to achieve temperatures of 22^{o}C in winter and 26^{o}C in summer, which are ordinary settings.	Equipment capacity is provided to achieve temperatures of 23^{o}C in winter and 26^{o}C in summer, which are ordinary settings.	Equipment capacity is provided to achieve temperatures of 18~20^{o}C in winter and 25~28^{o}C in summer, which are ordinary settings.	Equipment capacity is provided to achieve temperatures of 20^{o}C in winter and 26^{o}C in summer, which are ordinary settings.	**■Level 3**	Equipment capacity is provided to achieve temperatures of 22^{o}C in winter and 26^{o}C in summer, which are ordinary settings.	Equipment capacity is provided to achieve temperatures of 22^{o}C in winter and 26^{o}C in summer, which are ordinary settings.
Level 4					**Level 4**		

Level 5	Equipment capacity is provided to achieve temperatures of 24^{o}C in winter and 24^{o}C in summer.	Equipment capacity is provided to achieve temperatures of 24^{o}C in winter and 24^{o}C in summer.	**Level 5**	Equipment capacity is provided to achieve temperatures of 24^{o}C in winter and 24^{o}C in summer.	Equipment capacity is provided to achieve temperatures of 24^{o}C in winter and 24^{o}C in summer.

2.1.2 Variable Loads and Following-up Control

	Weighting coefficients (default)= 0.20
Level 3.0	Entire building and common properties
	Sch, Rtl, Rst, Hal
Level 1	No notable consideration has been given to sudden changes in loads.
Level 2	
■Level 3	General load variations are considered, and the system affords some degree of control.
Level 4	
Level 5	The control system allows advanced following-up control of load variations.

2.1.3 Perimeter Performance

	Weighting coefficients default)= 0.20		Weighting coefficients (default)= 0.00	
Level 3.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design		Preliminary Design	
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt		Hsp, Htl	Apt

Level 1	Insufficient attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and insulation blocking and insulation performance are poor.	**Level 1**	Insufficient attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and insulation blocking and insulation performance are poor.	Grade one-equivalent combinations of roof and exterior wall materials and opening specifications, as defined in the Japan Housing Performance Indication Standards “5-1 Energy-saving countermeasure grades,” have been set.
Level 2		**Level 2**		Grade two-equivalent combinations of roof and exterior wall materials and opening specifications, as defined in the Japan Housing Performance Indication Standards “5-1 Energy-saving countermeasure grades,” have been set.
Level 3	Attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and there is no practical problem with insulation blocking and insulation performance.	**Level 3**	Attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and there is no practical problem with insulation blocking and insulation performance.	Grade three-equivalent combinations of roof and exterior wall materials and opening specifications, as defined in the Japan Housing Performance Indication Standards “5-1 Energy-saving countermeasure grades,” have been set.
Level 4		**Level 4**		(No corresponding level)

<table>
<tr><td>Level 5</td><td>Close attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and the building has the highest level of insulation blocking and insulation performance.</td><td>Level 5</td><td>Close attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and the building has the highest level of insulation blocking and insulation performance.</td><td>Grade four-equivalent combinations of roof and exterior wall materials and opening specifications, as defined in the Japan Housing Performance Indication Standards “5-1 Energy-saving countermeasure grades,” have been set.</td></tr>
<tr><td rowspan="2"></td><td>Execution Design and Construction Completion</td><td rowspan="2"></td><td colspan="2">Execution Design and Construction Completion</td></tr>
<tr><td>Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt</td><td>Hsp, Htl</td><td>Apt</td></tr>
<tr><td>Level 1</td><td>No attention has been paid to the infiltration of heat through window systems, outside walls, roof and floor (particularly where piloti are used), and insulation performance is poor. (Window system SC: around 0.7, U=6.0(W /m2K), outer walls and others: U=3.0(W /m2K))</td><td>Level 1</td><td>No attention has been paid to the infiltration of heat through window systems, outside walls, roof and floor (particularly where piloti are used), and insulation performance is poor. (Window system SC: around 0.7, U=6.0(W /m2K), outer walls and others: U=3.0(W /m2K))</td><td rowspan="3">With annual heating and cooling load,
With thermal transmission loss coefficient and summer insolation acquisition coefficient</td></tr>
<tr><td>Level 2</td><td></td><td>Level 2</td><td></td></tr>
<tr><td>■Level 3</td><td>Attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and there is no practical problem with insolation blocking and insulation performance. (Window system SC: around 0.5, U=4.0(W /m2K), outer walls and others: U=2.0(W /m2K))1)</td><td>■Lev el 3</td><td>Attention has been paid to the infiltration of heat to the interior through windows, outside walls, roof and floor (particularly where piloti are used), and there is no practical problem with insolation blocking and</td></tr>
</table>

			insulation performance. (Window system SC: around 0.5, U=4.0(W /m2K), outer walls and thers: U=2.0(W /m2K))
Level 4		**Level 4**	
Level 5	Close attention has been paid to the infiltration of heat to the interior through windows systems, outside walls, roof and floor (particularly where piloti are used), and the building has the highest level of insolation blocking and insulation performance. (Window system SC: around 0.2, U=3.0(W /m2K), outer walls and others: U=1.0(W /m2K))	**Level 5**	Close attention has been paid to the infiltration of heat to the interior through windows systems, outside walls, roof and floor (particularly where piloti are used), and the building has the highest level of insolation blocking and insulation performance. (Window system SC: around 0.2, U=3.0(W /m2K), outer walls and others: U=1.0(W /m2K))

Annual heating and cooling load H (units: MJ/m2 year) subject Bldg.; **Area Category VI**

Zone*	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Level 1	840<[H]	980<[H]	980<[H]	980<[H]	980<[H]	980<[H]
Level 2	470<[H]=< 840	610<[H]=< 940	640<[H]=< 980	660<[H]=< 980	510<[H]=< 980	420<[H]=< 980
Level 3	390<[H]=< 470	390<[H]=< 610	460<[H]=< 640	460<[H]=< 660	350<[H]=< 510	290<[H]=< 420
Level 4	--	--	--	--	--	--

Level 5	[H]=<390	[H]=<390	[H]=<460	[H]=<460	[H]=<350	[H]=<290

Thermal transmission loss coefficient Q (units W/m2-K)

Zone*	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Level 1	2.8<[Q]	4.0<[Q]	4.4<[Q]	4.9<[Q]	7.1<[Q]	7.1<[Q]
Level 2	1.8<[Q]=< 2.8	2.7<[Q]=< 4.0	3.1<[Q]=< 4.4	3.6<[Q]=< 4.9	3.9<[Q]=< 7.1	6.2<[Q]=< 7.1
Level 3	1.6<[Q]=< 1.8	1.9<[Q]=< 2.7	2.4<[Q]=< 3.1	2.7<[Q]=< 3.6	2.7<[Q]=< 3.9	3.7<[Q]=< 6.2
Level 4	--	--	--	--	--	--
Level 5	[Q]=<1.6	[Q]=<1.9	[Q]=<2.4	[Q]=<2.7	[Q]=<2.7	[Q]=<3.7

Summer insolation acquisition coefficient μ

Zone*	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Level 1	--	--	--	--	--	--
Level 2	--	--	0.10<[μ]	0.10<[μ]	0.10<[μ]	0.08<[μ]
Level 3	0.08<[μ]	0.08<[μ]	0.07<[μ] =<0.10	0.07<[μ] =<0.10	0.07<[μ] =<0.10	0.06<[μ] =<0.08
Level 4	--	--	--	--	--	--
Level 5	[μ]=<0.08	[μ]=<0.08	[μ]=<0.07	[μ]=<0.07	[μ]=<0.07	[μ]=<0.06

※ I-VI represent regional categories The regional categories here correspond to those used in the “Standard for Judgment by Owner Regarding the Rational Use of Energy Relating for Housing Operation."

2.1.4 Zoned Control

Weighting coefficients (default)=	0.00

Level 3.0	Entire building and common properties		The following are examples of air conditioning systems corresponding to each level
	Off, Hsp, Htl, Fct	Rtl, Rst, Hal	
Level 1	No distinction is made between orientation directions, or between perimeter and interior, and only one air conditioning system is planned1), which must be switched between heating and cooling for each season	There is no zoning of heating and cooling within a single floor, and a single-circuit air conditioning system is planned.Switching between heating and cooling is required for the selection of air conditioning modes.	Single duct system, two-pipe FCU system (no zoning, switching between heating and cooling).

Level 2			
■Level 3	There are air conditioning zoning1) that differentiates between orientation directions, between perimeter and interior, and between internal load distributions. The air conditioning system can provide either heating or cooling separately to each zone.	Each floor is divided into multiple zones according to their thermal loads, and the air conditioning system is planned to allow either heating or cooling in each zone.	Single duct system, two-pipe FCU system (zoning grade assessment, switching between heating and cooling).
Level 4	There is air conditioning zoning at around the standard of Level 31), and the system also allows selection between cooling and heating for each zone.	There is air conditioning zoning at around the standard of Level 3, and the planned system also allows selection between cooling and heating for each zone.	Double duct system (4 pipes for AHU), four-pipe FCU system, task/ambient air conditioning system (evaluate both the zoning grade and simultaneous heating and cooling).
Level 5	There are separate air conditioning systems for each orientation direction, and for perimeter and interior, allowing more detailed zoning (broadly, zones of 40m2 or less). The air conditioning system can provide either heating or cooling separately to each zone.	Each floor is divided into many small zones for individual sales areas or tenants, and the air conditioning system is planned to allow either heating or cooling in zone units.	Multi-unit heat pump system (simultaneous heating and cooling), double duct system (4 pipes for AHU), four-pipe FCU system level with more detailed zoning than levels 3 and 4 (zones of around 40m2)

2.1.5 Temperature and Humidity Control

Level 3.0	Entire building and common properties (Weighting coefficients (default)= 0.10)	Level 3.0	Residential and Accommodation Sections (Weighting coefficients (default)= 0.00)
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt		Hsp, Htl
Level 1	On/Off control of temperature and humidity.	Level 1	On/Off control of temperature and humidity.
Level 2	Proportional or multiposition control of temperature and humidity.	Level 2	Proportional or multiposition control of temperature and humidity.
■Level 3	PID control of temperature and humidity.	■Level 3	PID control of temperature and humidity.

Level 4		**Level 4**	
Level 5	Comfort sensors etc. can be used to control temperature and humidity (temperature control within the comfort range).	**Level 5**	Comfort sensors etc. can be used to control temperature and humidity (temperature control within the comfort range).

2.1.6 Individual Control

Weighting coefficients (default)= 0.00

Level 3.0	Residential and Accommodation Sections	
	Hsp, Htl	Apt
Level 1	Occupants can manually switch air volume between low, middle and high	Not adequate for level 3.
Level 2		
■Level 3	Occupants can manually change the direct temperature setting and adjust air volume between low, middle and high.However, the heat source is switched between heating and cooling on a seasonal basis.	Temperature can be set for each individual room.
Level 4		
Level 5	Occupants can directly adjust temperature settings and airflow volumes with local controls.(Heat sources are for heating and cooling simultaneously)	The temperature for the whole dwelling can be set, and further settings can be made for each individual room.

2.1.7 Allowance for After-hours Air Conditioning

Weighting coefficients (default)= 0.20

Level 3.0	Entire building and common properties
	Off, Sch, Hsp, Htl, Fct

2.1.8 Monitoring Systems

Weighting coefficients (default)= 0.00

Level 3.0	Entire building and common properties
	Rtl, Rst

Level 1	Air conditioning does not operate after hours, or on holidays.	**Level 1**	There is no multiple zoning for separate loads on the same floor, but sensors or other monitoring systems are installed for monitoring a representative zone.
Level 2		**Level 2**	
■Level 3	The air conditioning system can operate for any whole floor that is occupied after hours and on holidays.	**■Level 3**	There is multiple zoning for separate loads on the same floor, and multiple monitoring and measurement sensors or other monitoring systems are installed in a monitoring system, apart from the control sensors for monitoring multiple zones.
Level 4		**Level 4**	
Level 5	The air conditioning system can operate for any zone that is occupied after hours and on holidays	**Level 5**	Each floor is zoned in detail for sales areas and tenants, and multiple monitoring and measurement sensors or other monitoring systems are installed in a monitoring system, other than control sensors, for monitoring those zones in detail.

2.2 Humidity Control

		Weighting coefficients (default)= 0.20			Weighting coefficients (default)= 0.00
Level 3.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design			Preliminary Design	
	Off, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Sch		Hsp, Htl	Apt
Level 1	The plan is for humidity to be free to vary within the 40~70% range set by the Building Environmental Health Law.	Humidity is planned to be set in range set for a range of 30% or above and 80% or below..	**Level 1**	Humidity is planned to vary within the 40~70% range set by the Law for Maintenance of Sanitation in Buildings Building Environmental Health Law.	No consideration given.
Level 2			**Level 2**		(No corresponding level)

Level 3	The system is planned to have humidification functions which will be generally set for 40% in winter and 50% in summer.	Humidification equipment is available, and planned to keep humidity to 50~65% in summer and 40~70% in winter.	**Level 3**	Humidification equipment is available, and planned to keep humidity to 50% in summer and 40% in winter.	Appropriate ventilation functions are provided, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.
Level 4			**Level 4**		Dehumidification functions are provided, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.
Level 5	The system is planned to have humidification and dehumidification functions, and to be set for a range of 45~55% with reference to the ASHRAE comfort zone and POEM-O.	The system is planned to have humidification and dehumidification functions, and to be set for a range of 45~55% with reference to the ASHRAE comfort zone and POEM-O.	**Level 5**	Humidification and dehumidification functions equipment is available, and to be set for a range of 45~55% with reference to the ASHRAE comfort zone and POEM-O.	Dehumidification and humidification functions are provided and set to a comfort range of 45~55%, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.
	Execution Design and Construction Completion			Execution Design and Construction Completion	
	Off, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Sch		Hsp, Htl	Apt
Level 1	Equipment capacity is sufficient to keep humidity to 70% in summer and 40% in winter.	Equipment capacity is sufficient to keep humidity to 80% or below in summer and 30% or above in winter.	**Level 1**	Equipment capacity is sufficient to keep humidity to70% in summer and 40% in winter.	No consideration given.
Level 2			**Level 2**		(No corresponding level)

■Level 3	Humidification equipment is available, and equipment capacity is generally sufficient to keep humidity to 50% in summer and 40% in winter.	Humidification equipment is also available, and equipment capacity is generally sufficient to keep humidity to 40~70% in winter and 50~65% in summer.	■Level 3	Humidification equipment is also available, and equipment capacity is generally sufficient to keep humidity to 50% in summer and 40% in winter.	Appropriate ventilation functions are provided, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.
Level 4			Level 4		Dehumidification functions are provided, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.
Level 5	Humidification and dehumidification equipment is available, and equipment capacity is sufficient to keep humidity to be set for a range of 45~55%.	Humidification and dehumidification equipment is available, and equipment capacity is sufficient to keep humidity to be set for a range of 45~55%	Level 5	Humidification and dehumidification equipment is availble, and equipment capacity is sufficient to keep humidity in the range 45~55%	Dehumidification and humidification functions are provided and set to a comfort range of 45~55%, and anti-condensation measures have been taken on elements that can act as heat bridges, such as insulation reinforcement, humidity barriers and permeable layers.

2.3 Type of Air Conditioning System

		Weighting coefficients (default)= 0.30			Weighting coefficients (default)= 0.00
Level 3.0	Entire building and common properties		Level 3.0	Residential and Accommodation Sections	
	Preliminary Design			Preliminary Design	
	Off, Sch, Rtl, Rst, Hal, Hsp(Waiting Room), Htl, Fct, Apt	Hsp(Examining Room)		Hsp, Htl	Apt

Level 1	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	**Level 1**	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system was chosen with no particular consideration for the vertical temperature distribution and airflow speed in air-conditioned rooms, or for temperature distribution between air-conditioned and non-air-conditioned rooms.
Level 2			**Level 2**		
Level 3	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in occupancy zone, and the partitions in the medeical examing rooms.	**Level 3**	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system was planned with consideration for the vertical temperature distribution and airflow speed in air-conditioned rooms, or for temperature distribution between air-conditioned and non-air-conditioned rooms.
Level 4			**Level 4**		
Level 5	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in occupancy zone, and to consider the partitions of the medical examing rooms.	**Level 5**	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in air-conditioned rooms, or for temperature distribution between air-conditioned and non-air-conditioned rooms.
	Execution Design and Construction Completion			Execution Design and Construction Completion	
	Off, Sch, Rtl, Rst, Hal, Hsp(Waiting Room), Htl, Fct, Apt	Hsp(Examining Room)		Hsp, Htl	Apt

Level 1	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	**Level 1**	The air conditioning system was planned with no particular consideration for the vertical temperature distribution and airflow speed in occupancy zone.	The air conditioning system was chosen with no particular consideration for the vertical temperature distribution and airflow speed in air-conditioned rooms, or for temperature distribution between air-conditioned and non-air-conditioned rooms.
Level 2			**Level 2**		
■Level 3	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in the room. Targets for vertical temperature distribution and airflow speed are set to within 5°C and 0.35m/s, respectively.	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in occupancy zone, and the partitions in the medeical examing rooms. Targets for vertical temperature distribution and airflow speed are set to within 5°C and 0.35m/s, respectively.	**■Level 3**	The air conditioning system is normal, but the air supply and extraction plan considered the vertical temperature distribution and airflow speed in the room. Targets for vertical temperature distribution and airflow speed are set to within 5°C and 0.35m/s, respectively.	Targets for vertical temperature distribution and airflow speed within rooms are set to within 4°C and 0.4m/s, respectively. Spot air conditioning is available even in non-air-conditioned areas such as toilets and bathrooms, mitigating temperature differences between rooms.
Level 4			**Level 4**		
Level 5	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in the room. Targets for vertical temperature distribution and airflow speed are set to within 2°C and 0.15m/s, respectively.	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in occupancy zone, and to consider the partitions of the medical examing	**Level 5**	The air conditioning system＊ was chosen to mitigate the vertical temperature distribution and airflow speed in the room. Targets for vertical temperature distribution and airflow speed are set	Targets for vertical temperature distribution and airflow speed within rooms are set to within 2°C and 0.2m/s, respectively. Air conditioning is available in all rooms, including rooms such as toilets and bathrooms, making it possible to eliminate temperature differences between rooms.

		rooms. Targets for vertical temperature distribution and airflow speed are set to within 2°C and 0.15m/s, respectively.		to within 2°C and 0.15m/s, respectively.	

∗ This refers to, for example, ceiling and floor radiant heating and cooling systems, or floor-vented systems etc.

3. Lighting & Illumination

3.1 Daylighting

3.1.1 Daylight Factor

Level 3.0	Entire building and common properties Off, Sch, Hsp, Htl, Fct, Apt	Level 3.0	Residential and Accommodation Sections Hsp, Htl	Apt
	Weighting coefficients (default)= 0.60			Weighting coefficients (default)= 0.00
Level 1	[Dayligt factor] <1.0%	**Level 1**	[Dayligt factor] <0.5%	[Dayligt factor] <0.5%
Level 2	1.0% =< [Dayligt factor] <1.5%	**Level 2**	0.5% =< [Dayligt factor] <0.75%	0.5% =< [Dayligt factor] <1.0%
■Level 3	1.5% =< [Dayligt factor] <2.0%	**■Level 3**	0.75% =< [Dayligt factor] <1.0%	1.0% =< [Dayligt factor] <1.5%
Level 4	2.0% =< [Dayligt factor] <2.5%	**Level 4**	1.0% =< [Dayligt factor] <1.25%	1.5% =< [Dayligt factor] <2.0%
Level 5	2.5% =< [Dayligt factor]	**Level 5**	1.25% =< [Dayligt factor]	2.0% =< [Dayligt factor]

3.1.2 Openings by Orientation

	Weighting coefficients (default)=	0.00

Level 3.0	Residential and Accommodation Sections
	Apt
Level 1	No south-facing windows.
Level 2	(No corresponding level)
■Level 3	South-facing windows.
Level 4	(No corresponding level)
Level 5	South and east-facing windows.

3.1.3 Daylight Devices

	Weighting coefficients (default)=	0.40		Weighting coefficients (default)=	0.00

Level 3.0	Entire building and common properties		Level 3.0	Residential and Accommodation Sections
	Off, Sch, Fct	Rtl, Rst, Hsp, Htl, Apt		Hsp, Htl, Apt
Level 1	(No corresponding level)	(No corresponding level)	Level 1	(No corresponding level)
Level 2	(No corresponding level)	(No corresponding level)	Level 2	(No corresponding level)
■Level 3	There are no daylight devices.	There are no daylight devices.	■Level 3	There are no daylight devices.
Level 4	There is one type of daylight device.	(No corresponding level)	Level 4	(No corresponding level)
Level 5	There are two or more types of daylight device, or they have advanced functions.	There are some daylight devices.	Level 5	There are some daylight devices.

3.2 Anti-glare Measures

3.2.1 Glare from Light Fixtures

	Weighting coefficients (default)=	0.40		Weighting coefficients (default)=	0.00

Level 3.0	Entire building and common properties	Level 3.0	Residential and Accommodation Sections
	Off, Hsp, Htl, Apt, Sch, Fct		Hsp, Htl, Apt

Level 1	The light source is exposed when viewed horizontally, and the light fixture does not restrict glare.G3 category fixtures.	**Level 1**	The light source is exposed when viewed horizontally, and the light fixture does not restrict glare.G3 category fixtures.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
■Level 3	The light source is not exposed when viewed horizontally, and the light fixture restricts glare.G2 category fixtures.	**■Level 3**	The light source is not exposed when viewed horizontally, and the light fixture restricts glare.G2 category fixtures.
Level 4	(No corresponding level)	**Level 4**	(No corresponding level)
Level 5	Use of reflective panel forms, louvers, transparent covers and other elements in light fixtures restrict glare.G1, G0 and V category fixtures.	**Level 5**	Use of reflective panel forms, louvers, transparent covers and other elements in light fixtures restrict glare.G1, G0 and V category fixtures.

3.2.2 Daylight Control

	Weighting coefficients (default)=	0.60			Weighting coefficients (default)=	0.00
Level 4.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections		
	Off, Sch, Hsp, Htl, Fct, Apt			Hsp, Htl, Apt		
Level 1	Nothing.		**Level 1**	Nothing.		
Level 2	Glare control using screens, awnings and eaves.		**Level 2**	(No corresponding level)		
Level 3	Glare is controlled with blinds, or by a combination of any two among screens, awnings and eaves.		**■Level 3**	Glare control using curtains, screens, awnings and eaves.		
■Level 4	Glare is controlled with blinds, together with any of one among screens, awnings and eaves.		**Level 4**	Glare is controlled with blinds, or a combination of any two among curtains, screens, awnings and eaves.		
Level 5	Glare is controlled by automatically-controlled blinds.		**Level 5**	Glare is controlled with blinds, together with any of one among curtains, screens, awnings and eaves.		

3.3 Illuminance Level

3.3.1 Illuminance

	Weighting coefficients (default)= 0.70					Weighting coefficients (default)= 0.00	
Level 3.0	Entire building and common properties				**Level 3.0**	Residential and Accommodation Sections	
	Off, Hsp(Examining Room), Fct	Hsp(Waiting Room)	Sch	Htl, Apt		Hsp	Htl, Apt
Level 1	[Illuminance] <500lx	[Illuminance] <150 lx	[Illuminance] <400lx	[Illuminance] <100 lx	**Level 1**	[Illuminance] <150 lx	[Illuminance] <100 lx
Level 2	500lx =< [Illuminance] <600lx	(No corresponding level)	400lx =< [Illuminance] < 500lx	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)
■Level 3	600lx =< [Illuminance] <750lx, or 1500lx =< [Illuminance]	150 lx =< [Illuminance]	500lx =< [Illuminance] <600lx, or 1000lx =< [Illuminance]	100 lx =< [Illuminance]	**■Level 3**	150 lx =< [Illuminance]	100 lx =< [Illuminance]
Level 4	750lx =< [Illuminance] <1000lx	(No corresponding level)	600lx =< [Illuminance] <750lx	(No corresponding level)	**Level 4**	(No corresponding level)	(No corresponding level)
Level 5	1000lx =< [Illuminance] <1500lx	(No corresponding level)	750lx =< [Illuminance] <1000lx	(No corresponding level)	**Level 5**	(No corresponding level)	(No corresponding level)

3.3.2 Uniformity of Illuminance

	Weighting coefficients (default)= 0.30		Weighting coefficients (default)= 0.00
Level 5.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections
	Off, Sch, Hsp(Examining Room), Htl, Fct, Apt		Hsp
Level 1	Overall lighting may leave very dark areas in the interior which can feel uncomfortable.	**Level 1**	Overall lighting may leave very dark areas in the interior which can feel uncomfortable.
Level 2	Overall lighting may leave dark areas in the interior which can feel slightly uncomfortable.	**Level 2**	Overall lighting may leave dark areas in the interior which can feel slightly uncomfortable.
Level 3	Overall lighting may leave dark areas in the interior to an acceptable degree.With task/ambient lighting, the balance between work surface brightness and surrounding brightness is inadequate.	**■Level 3**	Overall lighting may leave dark areas in the interior to an acceptable degree.With task/ambient lighting, the balance between work surface brightness and surrounding brightness is inadequate.

Level 4	With overall lighting, there are almost no dark areas in the interior.	**Level 4**	With overall lighting, there are almost no dark areas in the interior.
■Level 5	With overall lighting, there are no dark areas in the interior. With task/ambient lighting, the balance between work surface brightness and surrounding brightness is good.	**Level 5**	With overall lighting, there are no dark areas in the interior. With task/ambient lighting, the balance between work surface brightness and surrounding brightness is good.

3.4 Lighting Controllability

	Weighting coefficients (default)= 0.25		Weighting coefficients (default)= 0.00	
Level 5.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections	
	Preliminary Design		Preliminary Design	
	Off, Sch, Rtl, Hsp, Htl, Fct, Apt		Hsp	Htl, Apt
Level 1	No lighting control is possible	**Level 1**	No lighting control is possible	No lighting control is possible.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)
Level 3	Crude lighting control is possible in working rooms, sales areas etc.	**Level 3**	Rough lighting control is possible for multiple bed units.	Rough lighting control is possible for interiors.
Level 4	(No corresponding level)	**Level 4**	(No corresponding level)	(No corresponding level)
Level 5	Detailed lighting control is possible in individual working rooms, sales areas etc.	**Level 5**	Detailed lighting control is possible for individual bed units.	Detailed lighting control is possible for multiple areas of the interior.
	Execution Design and Construction Completion		Execution Design and Construction Completion	
	Off, Sch, Rtl, Hsp, Htl, Fct, Apt		Hsp	Htl, Apt
Level 1	Controll is not zoned and lighting cannot be adjusted from a control panel, from the fixtures or elsewhere.	**Level 1**	No lighting control is possible.	No lighting control is possible.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)

Level 3	Control is possible in units of 4 working areas. Lighting can be adjusted from a control panel, from the fixtures or elsewhere, and any of the conditions is met.	**■Level 3**	Controllable in units of several beds. Lighting can be adjusted from a control panel, from the fixtures or elsewhere.	There is a lighting control panel, device etc. for broadly controlling overall lighting in the room.
Level 4	(No corresponding level)	**Level 4**	(No corresponding level)	(No corresponding level)
■Level 5	Control is possible in units of 1 working area, and adjustment is possible from control terminals, remote controlor similar means.	**Level 5**	Detailed lighting control is possible for individual bed units.	There are terminals, remote control units or other means for detailed control of lighting in several areas of the interior.

4 Air Quality

4.1 Source Control

4.1.1 Chemical Pollutants

Level 3.0	Entire building and common properties (Weighting coefficients (default)= 0.33) Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	**Level 3.0**	Residential and Accommodation Sections (Weighting coefficients (default)= 0.00) Hsp, Htl, Apt
Level 1	(No corresponding level)	**Level 1**	(No corresponding level)
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
■Level 3	Satisfies the Building Standards Law.	**■Level 3**	Satisfies the Building Standards Law.
Level 4	Satisfies the Building Standard Law and uses construction materials not subject to regulation under the Building Standards Law (construction materials not covered by directives and having F★★★★ JIS/JAS standard rating) throughout (at least 70% by area of floors, walls, ceilings and ceiling voids).	**Level 4**	Satisfies the Building Standard Law and uses construction materials not subject to regulation under the Building Standards Law (construction materials not covered by directives and having F★★★★ JIS/JAS standard rating) throughout (at least 70% by area of floors, walls, ceilings and ceiling voids).

Level 5	Satisfies the Building Standard Law and uses construction materials not subject to regulation under the Building Standards Law (construction materials not covered by directives and having F ★★★★ JIS/JAS standard rating) throughout (at least 90% by area of floors, walls, ceilings and ceiling voids). The materials must also have low emission levels of VOCs other than formaldehyde.	**Level 5**	Satisfies the Building Standard Law and uses construction materials not subject to regulation under the Building Standards Law (construction materials not covered by directives and having F ★★★★ JIS/JAS standard rating) throughout (at least 90% by area of floors, walls, ceilings and ceiling voids). The materials must also have low emission levels of VOCs other than formaldehyde.

4.1.2 Asbestos

	Weighting coefficients (default)= 0.00		Weighting coefficients (default)= 0.00
Excluded	Entire building and common properties	**Excluded**	Residential and Accommodation Sections
	—		—
Level 1	-	**Level 1**	-
Level 2	-	**Level 2**	-
Level 3	-	**Level 3**	-
Level 4	-	**Level 4**	-
Level 5	-	**Level 5**	-

4.1.3 Mites, Mold etc.

	Weighting coefficients (default)= 0.33		Weighting coefficients (default)= 0.00
Level 1.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt		Hsp, Htl, Apt
■Level 1	Not adequate for level 3.	**Level 1**	Not adequate for level 3.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)

Level 3	The décor on at least 50%, but less than 65% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.	**■Level 3**	The décor on at least 50%, but less than 65% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.
Level 4	The décor on at least 65%, but less than 80% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.	**Level 4**	The décor on at least 65%, but less than 80% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.
Level 5	The décor on at least 80% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.	**Level 5**	The décor on at least 80% of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance.

4.1.4 Legionella

Weighting coefficients (default)= 0.33 | Weighting coefficients (default)= 0.00

Level 4.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Fct, Hsp	**Level 3.0**	Residential and Accommodation Sections Hsp, Htl, Apt
Level 1	Not adequate for level 3.	**Level 1**	Not adequate for level 3.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	There is a minimum level of water processing in water cooling towers, and measures against dispersion, and a minimum level of measures for water heaters.	**■Level 3**	There is a minimum level of water processing in water cooling towers, and measures against dispersion, and a minimum level of measures for water heaters.
■Level 4	There is no water cooling tower, or there is thorough water processing in water cooling towers, thorough measures against dispersion, and a minimum level of measures for water heaters.	**Level 4**	There is no water cooling tower, or there is thorough water processing in water cooling towers, thorough measures against dispersion, and a minimum level of measures for water heaters.
Level 5	There is no water cooling tower, or water processing in water cooling towers, measures against dispersion, and measures for water heaters are all thorough. There is also a good design for the maintenance of this equipment.	**Level 5**	There is no water cooling tower, or water processing in water cooling towers, measures against dispersion, and measures for water heaters are all thorough. There is also a good design for the maintenance of this equipment.

4.2 Ventilation

4.2.1 Ventilation Rate

Weighting coefficients (default)= 0.25 | Weighting coefficients (default)= 0.00

Level 4.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Level 3.0	Residential and Accommodation Sections Hsp, Htl, Apt
Level 1	(No corresponding level)	**Level 1**	(No corresponding level)
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	The ventilation volume is barely adequate to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and the Law for Maintenance of Sanitation in Buildings.	**■Level 3**	The ventilation volume is barely adequate to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and the Law for Maintenance of Sanitation in Buildings.
■Level 4	For occupied rooms equipped with centrally-managed air mixing equipment, the SHASE-S102-2003 ventilation standard and commentary are satisfied. If there is no central control, the ventilation volume is 1.2 times the level required to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and theLaw for Maintenance of Sanitation in Buildings.	**Level 4**	For occupied rooms equipped with centrally-managed air mixing equipment, the SHASE-S102-2003 ventilation standard and commentary are satisfied. If there is no central control, the ventilation volume is 1.2 times the level required to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and theLaw for Maintenance of Sanitation in Buildings.
Level 5	For occupied rooms equipped with centrally-managed air mixing equipment, the SHASE-S102-2003 ventilation standard and commentary are satisfied with a margin of 1.2 times. If there is no central control, the ventilation volume is 1.4 times the level required to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and the Law for Maintenance of Sanitation in Buildings.	**Level 5**	For occupied rooms equipped with centrally-managed air mixing equipment, the SHASE-S102-2003 ventilation standard and commentary are satisfied with a margin of 1.2 times. If there is no central control, the ventilation volume is 1.4 times the level required to satisfy the requirements of the Building Standards Law (including sick house syndrome countermeasures) and the Law for Maintenance of Sanitation in Buildings.

4.2.2 Natural Ventilation Performance

Weighting coefficients (default)= 0.25 (Entire building and common properties); Weighting coefficients (default)= 0.00 (Residential and Accommodation Sections)

Level 4.0	Entire building and common properties Off, Sch, Fct	Level 3.0	Residential and Accommodation Sections Hsp, Htl	 Apt
Level 1	Not adequate for level 3.	**Level 1**	Not adequate for level 3.	Not adequate for level 3.

Level 2	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)
Level 3	There is no effective opening for natural ventilation in occupied rooms with unopenable windows. Or, in rooms with openable windows, the area of effective opening for natural ventilation is at least 1/20 of the occupied room floor area.	**■Level 3**	There is no effective opening for natural ventilation in occupied rooms with unopenable windows. Or, in rooms with openable windows, the area of effective opening for natural ventilation is at least 1/20 of the occupied room floor area.	Openable windows are available for at least 1/10 of the floor area.
■Level 4	In rooms with unopenable windows, the area of effective opening for natural ventilation is at least 50cm2/m2. Or, in rooms with openable windows, the area of effective opening for natural ventilation is at least 1/15 of the occupied room floor area.	**Level 4**	In rooms with unopenable windows, the area of effective opening for natural ventilation is at least 50cm2/m2. Or, in rooms with openable windows, the area of effective opening for natural ventilation is at least 1/15 of the occupied room floor area.	Openable windows are available for at least 1/8 of the floor area.
Level 5	In rooms with unopenable windows, the area of effective openings for natural ventilation is at least 100cm2/m2 of floor area. Or, in rooms with openable windows, the area of effective openings for natural ventilation is at least 1/10 the floor area of the room.	**Level 5**	In rooms with unopenable windows, the area of effective openings for natural ventilation is at least 100cm2/m2 of floor area. Or, in rooms with openable windows, the area of effective openings for natural ventilation is at least 1/10 the floor area of the room.	Openable windows are available for at least 1/6 of the floor area.

4.2.3 Consideration for Outside Air Intake

	Weighting coefficients (default)=	0.25		Weighting coefficients (default)=	0.00
Level 5.0	Entire building and common properties		**Level 3.0**	Residential and Accommodation Sections	
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	Apt		Hsp, Htl	Apt
Level 1	Not adequate for level 3.	Not adequate for level 3.	**Level 1**	Not adequate for level 3.	Not adequate for level 3.
Level 2	(No corresponding level)	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)
Level 3	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents or positioned at least 3m away.	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site.	**■Level 3**	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents or positioned at least 3m away.	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site.
Level 4	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also positioned at least 6m away from extraction vents	(No corresponding level)	**Level 4**	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also positioned at least 6m away from extraction vents	(No corresponding level)
■Level 5	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents and positioned at least 6m away.	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents or positioned at least	**Level 5**	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents and positioned at least	The air intakes are oriented away from pollution sources, considering conditions in areas surrounding the site. They are also oriented away from extraction vents or positioned at least 3m away.

		3m away.		6m away.	

4.2.4 Air Supply Planning

Weighting coefficients (default)= 0.25 | Weighting coefficients (default)= 0.00

Level 3.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	Level 3.0	Residential and Accommodation Sections Hsp, Htl, Apt
Level 1	Not adequate for level 3	Level 1	Not adequate for level 3.
Level 2	(No corresponding level)	Level 2	(No corresponding level)
■Level 3	Outside air is mixed with return air in the air conditioning equipment and supplied to each room in a volume determined by the thermal load in that room, so the system does not guarantee delivery of an adequate volume of outside air to all rooms in all load conditions.	■Level 3	Outside air is mixed with return air in the air conditioning equipment and supplied to each room in a volume determined by the thermal load in that room, so the system does not guarantee delivery of an adequate volume of outside air to all rooms in all load conditions.
Level 4	(No corresponding level)	Level 4	(No corresponding level)
Level 5	Outside air is not mixed with return air, and is supplied directly to each room in the volume required for ventilation. Therefore, the system guarantees the necessary outside air, delivered to the places where it is needed, regardless of the load conditions in each room.	Level 5	Outside air is not mixed with return air, and is supplied directly to each room in the volume required for ventilation. Therefore, the system guarantees the necessary outside air, delivered to the places where it is needed, regardless of the load conditions in each room.

4.3 Operation Plan

4.3.1 CO2 Monitoring

Weighting coefficients (default)= 0.50

4.3.2 Control of Smoking

Weighting coefficients (default)= 0.50

Level 1.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Fct	Level 3.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp(Waiting Room), Htl, Fct
■Level 1	Not adequate for level 3.	Level 1	Not adequate for level 3.

Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	The system is based on manual measurement, with the minimum necessary level of recording	**■Level 3**	There is a minimum level of measures, such as smoking booths, to avoid exposing non-smokers to smoke.
Level 4	The system is based on manual measurement, a management manual etc. has been provided for properly maintaining air quality, and it functions effectively.	**Level 4**	(No corresponding level)
Level 5	The system has constant central monitoring of CO_2. Also, a management manual etc. has been provided for properly maintaining air quality, and it functions effectively.	**Level 5**	Smoking is confirmed to be prohibited in the entire building. Alternatively, there is an adequate level of measures, such as smoking booths, to avoid exposing non-smokers to smoke.

Q2 Quality of Service

Service Ability

1.1 Functionality & Usability

1.1.1 Provision of Space & Storage

Weighting coefficients (default)= 0.00

Weighting coefficients (default)= 0.00

Level 3.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections	
	Off, Fct		Hsp	Htl
Level 1	Not adequate for level 3	**Level 1**	Not adequate for level 3.	Not adequate for level 3
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)	(No corresponding level)
■Level 3	Working space per person is at least 6m2.	**■Level 3**	Private rooms at least 8m2/bed, multi-bed rooms at least 6m2/bed.	Single room at least 15m2, twin room at least 22m2.
Level 4	Working space per person is at least 9m2.	**Level 4**	(No corresponding level)	Single room at least 22m2, twin room at least 32m2.

Level 5	Working space per person is at least 12m2.	**Level 5**	Private rooms at least 10m2/bed, multi-bed rooms at least 8m2/bed.	Single room at least 30m2, twin room at least 40m2.

1.1.2 Use of Advanced Information System

Weighting coefficients (default)=	0.00		Weighting coefficients (default)=	0.00

Level 3.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections
	Off, Fct		Htl, Apt
Level 1	Not adequate for level 2.	**Level 1**	Not adequate for level 2.
Level 2	Measures such as OA floors etc. accommodate layout changes, and electrical sockets for OA equipment have at least 30VA/ m2 socket capacity. In addition, optical fiber is routed into the building for communications.	**Level 2**	Communications lines able to carry telephone and broadcasting are routed into each dwelling or guest room.
■Level 3	Measures such as OA floors accommodate layout changes, and electrical sockets for OA equipment have at least 30VA/m2 socket capacity. Also, level 2 is satisfied for communications, and communications lines with capacity for one data communications device per 8m2 (one phone, one PC) is routed onto each floor.	**■Level 3**	Level 2 is satisfied, and Internet services not adequate for level 4 are provided.
Level 4	Measures such as OA floors accommodate layout changes, and electrical sockets for OA equipment have at least 40VA/m2 socket capacity. Also, level 3 is satisfied for communications, lines for multiple communications carriers are routed into the building, and space is provided for each communications carrier to lay cables onto each floor.	**Level 4**	Each dwelling or guest room is equipped with a communications environment able to use 100Mbit-class broadband.
Level 5	Measures such as OA floors accommodate layout changes, and electrical sockets for OA equipment have at least 50VA/m2 socket capacity. Also, level 4 is satisfied for communications, Gigabit communications lines are routed onto each floor, and tenant EPS is ensured for communications between floors	**Level 5**	Each dwelling or guest room is equipped with a communications environment able to use Gbit-class broadband.

1.1.3 Barrier-free Planning

Weighting coefficients (default)=	1.00

Level	Entire building and common properties

3.0	Rtl, Rst, Hal, Hsp, Htl	Off, Sch, Fct, Apt
Level 1	Not adequate for level 3.	Not adequate for level 3.
Level 2	(No corresponding level)	(No corresponding level)
■Level 3	The building satisfies the standard for easing building use (the minimum level) under the New Barrier-free Building Law.	At least half of the building satisfies the standard for easing building use (the minimum level) under the New Barrier-free Building Law
Level 4	The building satisfies the standard for easing building use (the preferred level) under the New Barrier-free Building Law.	The building satisfies the standard for easing building use (the minimum level) under the New Barrier-free Building Law
Level 5	The building exceeds the standard for easing and guiding building use (the preferred level) under the New Barrier-free Building Law, achieving the universal design level.	The building satisfies the standard for easing building use (the desirable level) under the New Barrier-free Building Law

1.2 Amenity

1.2.1 Perceived Spaciousness & Access to View

Weighting coefficients (default)= 0.50

Weighting coefficients (default)= 0.00

Level 5.0	Entire building and common properties			Level 3.0	Residential and Accommodation Sections
	Off, Fct	Sch	Rtl, Rst		Hsp, Htl, Apt
Level 1	Not adequate for level 3.	Not adequate for level 3.	Not adequate for level 3	**Level 1**	Not adequate for level 3.

Level 2	(No corresponding level)	(No corresponding level)	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	The ceiling height is at least 2.5m in offices, and the windows are arranged to give all workers an adequate awareness of the outside.	Classroom ceiling height is at least 3m.	Sales area ceiling height is at least 3m.	**■Level 3**	Ceiling height at least 2.3m in Residential and Accommodation Sections.
Level 4	The ceiling height is at least 2.7m in offices, and the windows are placed to give all workers an adequate awareness of the outside.	Classroom ceiling height is at least 3.1m.	Sales area ceiling height is at least 3.3m.	**Level 4**	Ceiling height at least 2.5m in Residential and Accommodation Sections.
■Level 5	The ceiling height is at least 2.9m in offices, and the windows are placed to give all workers an adequate awareness of the outside.	Classroom ceiling height is at least 3.2m.	Sales area ceiling height is at least 3.6m	**Level 5**	Ceiling height at least 2.7m in Residential and Accommodation Sections.

1.2.2 Space for Refreshment

Weighting coefficients (default)= 0.00

Level 5.0	Entire building and common properties	
	Off, Fct	Rtl
Level 1	Not adequate for level 3.	Not adequate for level 3.
Level 2	(No corresponding level)	(No corresponding level)
Level 3	Smoking areas are provided.	Rest space is at least 2% of the sales floor area.
Level 4	Level 3 + refreshment areas.	Rest space is at least 3% of the sales floor area.
■Level 5	Level 4 + installation of vending machines etc.	Rest space is at least 4% of the sales floor area.

1.2.3 Décor Planning

Weighting coefficients (default)= 0.50

Weighting Coefficients (default)= 0.00

Level 4.0	Entire building and common properties	**Level**	Residential and Accommodation Sections
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt		Hsp, Htl, Apt

Level 1	Not adequate for level 3.	**Level 1**	Not adequate for level 3.
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	Applicable to two of the efforts to be evaluated.	**Level 3**	Applicable to two of the efforts to be evaluated.
■Level 4	Applicable to three of the efforts to be evaluated.	**Level 4**	Applicable to three of the efforts to be evaluated.
Level 5	Applicable to four of the efforts to be evaluated.	**Level 5**	Applicable to four of the efforts to be evaluated.

Level 3.0	<-- Direct input	**Level 3.0**	<-- Direct input
Level 4.0	Entire building and common properties Efforts to be evaluated	**Level 3.0**	Residential and Accommodation Sections Efforts to be evaluated
yes	The concept of the building as a whole is well defined, and specific efforts to reflect the concept are made at the décor planning stage.(For example, shifting to natural and ecological materials in a building with an ecological theme).	yes	The concept of the building as a whole is well defined, and specific efforts to reflect the concept are made at the décor planning stage.(For example, shifting to natural and ecological materials in a building with an ecological theme).
yes	The functions required of the building have been clarified, and specific measures to encourage those functions are indicated at the décor planning stage.(For example, in hotels and similar facilities, the interior is perceived as living space, and natural materials such as wood and stone are introduced in deliberate efforts to produce a living room-like atmosphere.	yes	The functions required of the building have been clarified, and specific measures to encourage those functions are indicated at the décor planning stage.(For example, in hotels and similar facilities, the interior is perceived as living space, and natural materials such as wood and stone are introduced in deliberate efforts to produce a living room-like atmosphere.
yes	The lighting planning and décor planning are integrated with specific measures at the décor planning stage.		The lighting planning and décor planning are integrated with specific measures at the décor planning stage.
	Mockups and interior perspectives are used to verify the décor planning in advance.		Mockups and interior perspectives are used to verify the décor planning in advance.

1.3 Maintenance Management

1.3.1 Design Which Considers Maintenance Management

Weighting coefficients(default)=	0.50

Level 3.0	Entire building and common properties Off, Sch, Rtl, Hal, Htl	Remarks
Level 1	(No corresponding level)	Buildings to which the Law for Maintenance of Sanitation in Buildings does not apply are excluded. This assessment covers efforts on matters which should be considered in selecting structures and materials at the building design stage for the sake of maintenance management.
Level 2	Efforts to consider maintenance management at the design stage were inadequate. (0~2 Efforts to be evaluated)	
■Level 3	Efforts to consider maintenance management at the design stage were standard. (3~5 Efforts to be evaluated)	
Level 4	Efforts to consider maintenance management at the design stage were above the standard level. (6~8 Efforts to be evaluated)	
Level 5	Efforts to consider maintenance management at the design stage were comprehensive. (9~ Efforts to be evaluated)	

Efforts to be evaluated

Judgment	Evaluated content
yes	[1] Interior finishes: Interior walls use finish methods, materials, paints or coatings that are highly dirt resistant.
yes	[2] Interior finishes: Floors use finish methods, materials, paints or coatings that are highly dirt resistant.
	[3] Décor planning: The design and structure of floors enables washing with water.
	[4] Décor design: Design of interior walls and floors avoids creating dust traps and places to leave objects.
	[5] Décor design: The first and second doors of windbreak lobbies are distanced so that they are not open at the same time, or are otherwise designed to prevent the entry of dust etc.
	[6] Décor design: Floor materials with very different maintenance management methods are not placed close together.

	[7] Exterior finishes: Exterior walls and glass are designed with highly dirt resistant construction materials, or with finishes such as weather-resistant paint and hydrophilic properties.
	[8] Facade design: Exterior walls are equipped with effective rain flashing, and the flow of water down the walls has been considered, in order to avoid dirtying of the wall surfaces.
	[9] Facade design: Measures have been applied to prevent damage from the droppings of pest birds (pigeons, crows, starlings, etc.).
yes	[10] Facade design: Metal parts exposed on the exterior are plated or otherwise treated against corrosion.
	[11] Décor and exterior space design: Movement routes, including outdoor spaces and management areas, are designed to eliminate steps as far as possible (steps not exceeding around 5mm).
	[12] Other: Efforts have been made in areas other than the above, with consideration for maintenance management.
Total=	**3 Point**

1.3.2 Securing Maintenance Management Functions

Weighting coefficients(default)=	0.50

Level 4.0	Entire building and common properties	Remarks
	Off, Sch, Rtl, Hal, Htl	
Level 1	(No corresponding level)	Buildings to which the Law for Maintenance of Sanitation in Buildings does not apply are excluded. In this assessment, assess efforts related to basic functional items needed to achieve a high-quality level of maintenance management.
Level 2	Efforts to ensure maintenance management functions are inadequate. (0~3 Efforts to b evaluated)	
Level 3	Efforts to ensure maintenance management functions are standard (4~6 Efforts to b evaluated)	
■Level 4	Efforts to ensure maintenance management functions above the standard level.(7~9 Efforts to b evaluated)	
Level 5	Extensive efforts are made to ensure maintenance management functions.(10 or more Efforts to b evaluated)	

Efforts to be evaluated

Judgment	Evaluated content
	[1] Adequate space has been used for cleaning staff rooms, relative to the floor area.

yes	[2] Adequate space has been used for cleaning equipment rooms, relative to the floor area.
yes	[3] The cleaning equipment rooms have washing areas with drainage channels to safe drainage facilities.
yes	[4] Space is planned for washing and drying mops and rags, for the sake of hygiene.
yes	[5] Adequate space has been provided for sorting waste, materials for recycling, and bulky garbage items, relative to the floor area, and an easy way to move those materials outside has been planned.
	[6] Cleaning sinks are installed for each toilet, or for each floor.
	[7] Cleaning equipment for each type of floor material has been anticipated, and the layout of electrical receptacles (numbers and spacings) for use in cleaning work has been planned accordingly.
	[8] Design ensures that maintenance management work can be performed safely on exterior glass and walls, air supply and vent holes, light fixtures and other fixtures in high places.
yes	[9] Suitable levels of lighting for cleaning purposes can be set.
yes	[10] Valves and other devices requiring day-to-day adjustment are installed in positions which allow convenient operation.
yes	[11] Inspection access holes for equipment concealed in ceiling voids are at least 600x600mm.
yes	[12] Equipments not serving for private areas can be accessed from common areas for maintenance management.
	[13] Other than the above, points related to securing maintenance management functions have been identified and implemented.
Total=	**8 Point**

2. Durability & Reliability

2.1 Earthquake Resistance

2.1.1 Earthquake-resistance

Weighting coefficients (default)= 0.80

Level 3.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	(No corresponding level)

2.1.2 Seismic Isolation & Vibration Damping Systems

Weighting coefficients (default)= 0.20

Level 3.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	(No corresponding level)

■Level 3	The building's earthquake resistance meets the requirements of the Building Standards Law.	■Level 3	No seismic isolation or vibration damping system is used.
Level 4	The building's earthquake resistance exceeds the requirements of the Building Standards Law by a 20% margin.	Level 4	A vibration damping system is installed. Improved comfort in strong wind is considered.
Level 5	The building's earthquake resistance exceeds the requirements of the Building Standards Law by a 50% margin. Alternatively, damage control design has been used.	Level 5	A seismic isolation system is used

2.2 Service Life of Components

2.2.1 Service Life of Structural Frame Materials	Weighting coefficients (default)= 0.23	**2.2.2 Necessary Refurbishment Interval for Exterior Finishes**	Weighting coefficients(default)= 0.23
Level 3.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	**Level 3.0**	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)	**Level 1**	Less than 10 years
Level 2	(No corresponding level)	**Level 2**	10 years or more, less than 20 years
■Level 3	This is grade 1 of the assessment standard for steel frame and concrete buildings (Ministry of Land, Infrastructure, Transport and Tourism directive 380, 2006) in the Housing Quality Assuarance Law (Japan Housing Performance Standards, 3. Matters for relieving deterioration).	**■Level 3**	20 years
Level 4	This is grade 2 of the assessment standard for steel frame and concrete buildings (Ministry of Land, Infrastructure, Transport and Tourism directive 380, 2006) in the Housing Quality Assuarance Law (Japan Housing Performance Standards, 3. Matters for relieving deterioration).	**Level 4**	21 years or more, less than 30 years
Level 5	This is grade 3 of the assessment standard for steel frame and concrete buildings (Ministry of Land, Infrastructure, Transport and Tourism directive 380, 2006) in the Housing Quality Assuarance Law (Japan Housing Performance Standards, 3. Matters for relieving deterioration).	**Level 5**	30 years or more

2.2.3 Necessary Renewal Interval for Main Interior Finishes	Weighting coefficient s(default)= 0.09	**2.2.4 Necessary Replacement Interval for Air Conditioning and**	Weighting coefficients (default)= 0.08

Level 3.0	Entire building and common properties	
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	Apt
Level 1	Less than 5 years	Less than 10 years
Level 2	5 years or more, less than 10 years	10 years or more, less than 20 years
■Level 3	10 years	15 years
Level 4	11 years or more, less than 20 years	16 years or more, less than 25 years
Level 5	20 year or more	25 years or more

Ventilation Ducts

Level 3.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	(No corresponding level)
Level 2	(No corresponding level)
■Level 3	Zinc-plated steel sheet used almost throughout.
Level 4	Exposed exterior ducts, kitchen venting ducts, high-humidity venting ducts and similar applications that would have shorter service lives than other applications when made from zinc-plated steel sheet are made from stainless steel or Galvalume to extend service life. Alternatively, appropriate provision has been made for drainage of internal condensation.
Level 5	At least 90% of exposed exterior ducts, kitchen venting ducts, high-humidity venting ducts and similar applications that would have shorter service lives than other applications when made from zinc-plated steel sheet are made from stainless steel or Galvalume to extend service life.

2.2.5 Necessary Renewal Interval for HVAC and Water Supply and Drainage Pipes

Weighting coefficients (default)= 0.15

Level 3.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	(No corresponding level)
Level 2	(No corresponding level)
■Level 3	D or better used in almost all the top three main applications.
Level 4	C or better used in at least two of the top three main applications.

2.2.6 Necessary Renewal Interval for Major Equipment and Services

Weighting coefficients (default)= 0.23

Level 3.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	Less than 7 years
Level 2	7 years or more, less than 15 years
■Level 3	15 years
Level 4	16 years or more, less than 30

			years
Level 5	B or better used in at least two of the top three main applications, and E is not used.	**Level 5**	30 years or more

2.3 Appropriate renewal

<Inapplicable under CASBEE – New Construction>

2.4 Reliability

2.4.1 HVAC System

Weighting coefficients (default)= 0.20

Level 1.0	Entire building and common properties	
	Off, Hal, Hsp, Htl, Fct	Sch, Rtl, Rst, Apt
■Level 1	No efforts to be evaluated.	No efforts to be evaluated.
Level 2	(No corresponding level)	(No corresponding level)
Level 3	Applicable to one of the efforts to be evaluated. Alternatively, there is no centralized HVAC system.	Applicable to one of the efforts to be evaluated. Alternatively, there is no centralized HVAC system.
Level 4	Applicable to two of the efforts to be evaluated.	(No corresponding level)
Level 5	Applicable to three or more of the efforts to be evaluated.	Applicable to two or more of the efforts to be evaluated.

Evaluate the efforts to improve the reliability of HVAC system.

Level 3.0	<-- Direct input	
Building Type	Off, Hal, Hsp, Htl, Fct	Sch, Rtl, Rst, Apt
Gross Floor Area	m²	4,322m²
Judgment	**Level 1.0**	**Level 1.0**

2.4.2 Water Supply & Drainage

Weighting coefficients (default)= 0.20

Level 3.0	Entire building and common properties	
	Off, Sch, Hal, Hsp, Htl, Fct, Apt	Rtl, Rst
Level 1	No efforts to be evaluated.	No efforts to be evaluated.
Level 2	(No corresponding level)	(No corresponding level)
■Level 3	Applicable to one of the efforts to be evaluated.	Applicable to one of the efforts to be evaluated.
Level 4	Applicable to tow of the efforts to be evaluated.	(No corresponding level)
Level 5	Applicable to three or more of the efforts to be evaluated.	Applicable to two or more of the efforts to be evaluated.

Evaluate the efforts to improve the reliability of water supply and drainage.

Level 1.0	<-- Direct input	
Building Type	Off, Sch, Hal, Hsp, Htl, Fct, Apt	Rtl, Rst
Gross Floor Area	4,322m²	m²
Judgment	**Level 3.0**	**Level 3.0**

Yes	Select from among the methods listed below, if the HVAC system has an operation control system for multiple occupied rooms.	yes	Water-saving equipment is used. This is lilimited to cases where it is used on a majority of the installed equipment. Water-saving devices are those approved as Eco Mark products, or those equivalent to water-saving equipment that is the approval standard for Eco Mark products.
	"Yes", please select from comments.		Plumbing systems are separated as far as possible to reduce the portions that become unserviceable in the event of a disaster.
	Circuits are divided according to the importance of their ventilation equipment, and more important circuits are given priority in operation after a disaster. Also, ways of running the ventilation with reduced load capacity have been examined.		The building has a pit for temporary waste water storage, in case mains sewerage is unavailable after a disaster.
	Dispersion and duplication of heat source types (electricity, gas etc.), with backups.		The building has two separate tanks, one for water reception and one elevated tank.
	Countermeasures (such as suspended pipes) have been taken to ensure that overall function can continue even when the building is partially damaged by an earthquake.		Planning enables the use of well water, gray water and etc.
	Circuits are divided according to the importance of their air conditioning equipment, and more important circuits are given priority in operation after a disaster. Also, ways of running the air conditioning with reduced load capacity have been examined.		The building is equipped with a simple filtration system allowing conversion of rainwater to potable water in the event of a disaster. (Not applied to"Retailers" and "Restaurant.")

2.4.3 Electrical Equipment

Weighting coefficient s(default)= 0.20

Level 1.0	Entire building and common properties	
	Off, Hal, Hsp, Htl, Fct	Sch, Rtl, Rst, Apt
■Level 1	No efforts to be evaluated.	No efforts to be evaluated.
Level 2	(No corresponding level)	(No corresponding level)
Level 3	Applicable to one of the efforts to be evaluated.	Applicable to one of the efforts to be evaluated.

2.4.4 Support Method of Machines & Ducts

Weighting coefficients (default)= 0.20

Level 1.0	Entire building and common properties
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
■Level 1	Not adequate for level 3
Level 2	(No corresponding level)
Level 3	Earthquake resistance class B (Human safety is assured and secondary damage prevented after a major earthquake.)

Level 4	Applicable to tow of the efforts to be evaluated.	(No corresponding level)	**Level 4**	Earthquake resistance class A (In addition to Class B, important functions can be secured without major repairs)
Level 5	Applicable to three or more of the efforts to be evaluated.	Applicable to two or more of the efforts to be evaluated.	**Level 5**	Earthquake resistance class S (In addition to Class A, all functions can be secured without major repairs)

Evaluate the efforts to improve the reliability of electrical equipment

Level 3.0	<-- Direct input	
Building Type	Off, Hal, Hsp, Htl, Fct	Sch, Rtl, Rst, Apt
Gross Floor Area	m²	4,322m²
Judgment	**Level 1.0**	**Level 1.0**
	The building is equipped with emergency generators. (Not applied to"Schools," "Retailers," "Restaurants" and "Appartments.")	
	The building is equipped with uninterruptible power source systems.	
	Power input equipment for important equipment systems has redundancy. (Not applied to "Schools," "Retailers," "Restaurants" and "Apartments.")	
	Countermeasures (i) and (ii) have been taken or (iii) applies, in order to avoid power outages due to water percolation into power supply equipment or precision machinery, and to avoid damage to data networks. (i) Installation of power supply equipment and precision machinery below ground is avoided. (ii) Devices to prevent the groundwater percolation (waterproof doors, waterproof panels, embankments, dry ditches) and drainage equipment (pumps etc.) are installed. (iii) No danger of water percolation.	

2.4.5 Communications & IT Equipment

Weighting coefficients (default)= 0.20

Level 1.0	Entire building and common properties			
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct		Apt	
■Level 1	No efforts to be evaluated.		No efforts to be evaluated.	

Level 2	(No corresponding level)	(No corresponding level)
Level 3	Applicable to one of the efforts to be evaluated.	Applicable to one of the efforts to be evaluated.
Level 4	Applicable to tow of the efforts to be evaluated.	Applicable to tow of the efforts to be evaluated.
Level 5	Applicable to three of the efforts to be evaluated.	Applicable to three of the efforts to be evaluated.

Evaluate the efforts to improve the reliability of communications and IT equipment

Level 3.0	<-- Direct input		
Building Type	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct		Apt
Gross Floor Area	4,322㎡		㎡
Judgment	**Level 1.0**		**Level 1.0**
	Communications methods are diversified, using optical fiber cable, metal cable, cellular telephone network, PHS network and others.		
	Connections are made from two telephone exchanges to secure two communications links.		
	Countermeasures (i) and (ii) have been taken or (iii) applies, in order to avoid damage to data networks due to water percolation into precision machinery. (i) Installation of precision machinery below ground is avoided.(ii) Devices to prevent the groundwater percolation (waterproof doors, waterproof panels, embankments, dry ditches) and drainage equipment (pumps etc.) are installed. (iii) No danger of water percolation.		

3. Flexibility & Adaptability

3.1 Spatial Margin

3.1.1 Allowance for Floor-to-floor Height

Weighting coefficients (default)=	0.60	Weighting coefficients (default)=	0.00
Level 3.0	Entire building and common properties	**Level 3.0**	Residential and Accommodation Sections

	Off, Sch, Rtl, Rst, Hsp, Fct		Hsp, Htl	Apt
Level 1	Less than 3.3m	**Level 1**	Less than 3.3m	Less than 2.7m
Level 2	3.3m or more, less than 3.5m	**Level 2**	3.3m or more, less than 3.5m	2.7m or more, less than 2.8m
■Level 3	3.5m or more, less than 3.7m	**■Level 3**	3.5m or more, less than 3.7m	2.8m or more, less than 2.9m
Level 4	3.7m or more, less than 3.9m	**Level 4**	3.7m or more, less than 3.9m	2.9m or more, less than 3.0m
Level 5	3.9m or more	**Level 5**	3.9m or more	3.0m or more

3.1.2 Adaptability of Floor Layout

Weighting coefficients (default)= 0.40

Weighting coefficients (default)= 0.00

Level 3.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Fct, Hsp	**Level 3.0**	Residential and Accommodation Sections Hsp, Htl, Apt
Level 1	0.7=< [Wall length/area ratio]	**Level 1**	0.7=< [Wall length/area ratio]
Level 2	0.5=< [Wall length/area ratio] <0.7	**Level 2**	0.5=< [Wall length/area ratio] <0.7
■Level 3	0.3=< [Wall length/area ratio] <0.5	**■Level 3**	0.3=< [Wall length/area ratio] <0.5
Level 4	0.1=< [Wall length/area ratio] <0.3	**Level 4**	0.1=< [Wall length/area ratio] <0.3
Level 5	[Wall length/area ratio] <0.1	**Level 5**	[Wall length/area ratio] <0.1

$$\text{Wall length/area ratio} = \frac{\text{Length of perimeter walls (m) + length of bearing walls (m)}}{\text{Exclusive area (m2)}}$$

3.2 Floor Load Margin

Weighting coefficients (default)= 0.31

Weighting coefficients (default)= 0.00

Level 3.0	Entire building and common properties			**Level 3.0**	Residential and Accommodation Sections
	Off, Rtl, Rst, Hal(fixed seatings), Fct, Hsp	Hal(non-fixed seatings)	Sch		Hsp, Htl, Apt
Level 1	(No corresponding level)	(No corresponding level)	(No corresponding level)	**Level 1**	(No corresponding level)
Level 2	Less than 2900N/m2	Less than 3500N/m2	Less than 2300N/m2	**Level 2**	Less than 1800N/m2
■Level 3	2900N/m2 or more	3500N/m2	2300N/m2 or	**■Lev**	1800N/m2 or

		or more	more	el 3	more
Level 4	3500N/m2 or more	4200N/m2 or more	2900N/m2 or more	**Level 4**	2100N/m2 or more
Level 5	4500N/m2 or more	5200N/m2 or more	3500N/m2 or more	**Level 5**	2900N/m2 or more

3.3 Adaptability of Facilities

3.3.1 Ease of Air Conditioning Duct Renewal

Weighting coefficients (default)= 0.17

Level 5.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Fct, Htl, Apt
Level 1	Air conditioning ducts cannot be replaced or repaired without damaging structural elements.
Level 2	In some cases the air conditioning ducts can be replaced or repaired without damaging structural elements, if spare sleeves are used, but that method cannot be applied to all ducts.
Level 3	Space and routes for future use (future replacement work) have been provided, so that nearly all air conditioning ducts can be replaced or repaired without damaging structural elements. Alternatively, there is no central air conditioning equipment.
Level 4	Exterior air conditioning ducts are used or ceiling space provided so that ducts can be replaced or repaired without damaging either structural elements or surface finishes.
■Level 5	ISS, equipment floor installation or other measures allow easy replacement or repair of air conditioning ducts without damaging surface finishes.

3.3.2 Ease of Water Supply and Drain Pipe Renewal

Weighting coefficients (default)= 0.17

Level 5.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	Repair and replacement are not possible without damaging structural elements and finishes.
Level 2	Repairs can be made without damaging structural elements, but replacements cannot.
Level 3	Repairs can be made without damaging structural elements and finishes, but replacements cannot.
Level 4	Repairs and replacements can be made without damaging structural elements.
■Level 5	Repair and replacement are possible without damaging structural elements or finishes.

3.3.3 Ease of Electrical Wiring Renewal

Weighting coefficients (default)= 0.11

Level 5.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	Wiring cannot be replaced or repaired without damaging structural elements.

3.3.4 Ease of Communications Cable Renewal

Weighting coefficients (default)= 0.11

Level 5.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	Communications cables cannot be replaced or repaired without damaging structural elements.

Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	Wiring can be replaced or repaired without damaging structural elements.	**Level 3**	Communications cables can be replaced or repaired without damaging structural elements.
Level 4	(No corresponding level)	**Level 4**	(No corresponding level)
■Level 5	Wiring can be replaced or repaired without damaging structural elements or surface finishes.	**■Level 5**	Communications cables can be replaced or repaired without damaging structural elements or surface finishes.

3.3.5 Ease of Equipment Renewal	Weighting coefficients (default)= 0.22	**3.3.6 Provision of Backup Space**	Weighting coefficients (default)= 0.22
Level 5.0	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	**Level 3.0**	Entire building and common properties Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	No machine hatches or routes to accommodate replacement of major service equipment are provided, and building functions cannot be maintained through replacement and repair.	**Level 1**	(No corresponding level)
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
Level 3	Machine hatches or routes to accommodate replacement of major service equipment are provided, but building functions cannot be maintained through replacement and repair.	**■Level 3**	There is no planned provision of space for backup equipment
Level 4	(No corresponding level)	**Level 4**	There is planned provision of space for backup equipment.
■Level 5	Machine hatches or routes to accommodate replacement of major service equipment are provided, and building functions can be maintained through replacement and repair.	**Level 5**	(No corresponding level)

■Transfer the necessary entries from the report of "Energy-saving plan "&" the Housing

Performance Assessment"

(cyan box)	Select from pull-down menus or enter figures and comments.

			Entire building	Office	School	Retailers	Restaurants	Halls	Factories	Hospitals	Hotels
	Building Type		Entire building	Office	School	Retailers	Restaurants	Halls	Factories	Hospitals	Hotels
	Floor area for each building type	m2	4,322		4,322						
Building plan	For each assessment standard type			**PAL value**	**PAL value**	**PAL value**	**PAL value**	**PAL value**	**PAL value**	**PAL value**	**PAL value**
	PAL value	MJ/m2-yr		**300.0**	**259.0**	**380.0**	**550.0**	**550.0**		**340.0**	**42.0**
	The standard for judgment by owner	MJ/m2-yr		300	320	380	550	550		340	420
	Point value, Insulation class	Point		**100**	**200**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point		100	100	100	100	100		100	100
	LR1/1.Building Thermal Load			Level 3.0	Level 4.0	Level 3.0	Level 3.0	Level 3.0		Level 3.0	Level 5.0

Entire building	**LR1/1.Building Thermal Load**	**Level 4.0**	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00

HVAC system	For each assessment standard type		**CEC/AC value**	**CEC/AC value**	**CEC/AC value**	**CEC/AC value**	**CEC/AC value**	**CEC/AC value**	**CEC/AC value**	**CEC/AC value**
	CEC/AC value	(-)	**1.5**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	The standard for	(-)	1.5	1.5	1.7	2.2	2.2	—	2.5	2.5

	judgment by owner										
	Annual energy consumption	MJ/yr	1,968,000	92,664	0	0	0	0	0	0
	Annual Hypothetical Air Conditioning Load	MJ/yr	**1,312,000**	**280,800**	**0**	**0**	**0**	**0**	**0**	**0**
	Point value	Point	**100**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	correction Point	Point	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point	100	100	100	100	100	—	100	100
	LR1/3.1 HVAC System		**Level 3.0**	**Level 5.0**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Level 0.0**	**Input CEC value**	**Input CEC value**
	weight		0.45	0.76	0.40	0.40	0.40	—	0.55	0.40
Ventilation System	For each assessment standard type		**CEC/V value**	**Excluded**	**CEC/V value**	**CEC/V value**	**CEC/V value**	**CEC/V value**	**CEC/V value**	**CEC/V value**
	CEC/V value	(-)	**1.0**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	The standard for judgment by owner	(-)	1.0	—	0.9	1.5	1.0	—	1.0	1.0
	Annual energy consumption	MJ/yr	678,300	0	0	0	0	0	0	0
	Hypothetical energy consumption for ventilation per year	MJ/yr	**678,300**	**115,200**	**0**	**0**	**0**	**0**	**0**	**0**
	Point value	Point	**150**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point	100	100	100	100	100	—	100	100
	LR1/3.2 Ventilation System		**Level 3.0**	**Level 0.0**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Level 0.0**	**Input CEC value**	**Input CEC value**
	weight		0.15	—	0.10	0.10	0.10	—	0.10	0.15
Lighting System	For each assessment standard type		**CEC/L value**	**CEC/L value**	**CEC/L value**	**CEC/L value**	**CEC/L value**	**CEC/L value**	**CEC/L value**	**CEC/L value**

	CEC/L value	(-)	**1.0**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	The standard for judgment by owner	(-)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Annual energy consumption	MJ/yr	4,048,000	148,176	0	0	0	0	0	0
	Hypothetical energy consumption for lighting per year	MJ/yr	**4,048,000**	**302,400**	**0**	**0**	**0**	**0**	**0**	**0**
	Point value	Point	**160**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point	100	100	100	100	100	100	100	100
	LR1/3.3 Lighting System		**Level 3.0**	**Level 5.0**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**
	weight		0.30	0.24	0.35	0.35	0.35	0.85	0.20	0.20
Hot Water Supply System	For each assessment standard type		**CEC/HW value**	**Excluded**	**CEC/HW value**	**CEC/HW value**	**CEC/HW value**	**CEC/HW value**	**CEC/HW value**	**CEC/HW value**
	CEC/HW value	(-)	**1.68**	**1.08**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Ix value									
	The standard for judgment by owner	(-)	1.6	—	Input Ix value	Input Ix value	Input Ix value	Input Ix value	Input Ix value	Input Ix value
	Annual energy consumption	MJ/yr	312,000	0	0	0	0	0	0	0
	Hypothetical hot water supply load per year	MJ/yr	**195,000**	**195,000**	**0**	**0**	**0**	**0**	**0**	**0**
	Point value	Point	**160**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point	100	100	100	100	100	100	100	100
	LR1/3.4 Hot Water Supply System		**Level 3.0**	**Level 0.0**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**	**Input CEC value**
	weight		0.05	—	0.15	0.15	0.15	0.15	0.15	0.20

Elevators	For each assessment standard type		**CEC/EV value**	**CEC/EV value**	**CEC/EV value**	**CEC/EV value**	**CEC/EV value**	**CEC/EV value**	**CEC/EV value**	**CEC/EV value**
	CEC/EV value	(-)	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	The standard for judgment by owner	(-)	1.0	―	―	―	―	―	―	1.0
	Annual energy consumption	MJ/yr	134,900	0	0	0	0	0	0	0
	Hypothetical energy consumption for elevator per year	MJ/yr	**134,900**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Point value	Point	**150**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	The standard for judgment by owner	Point	100	―	―	―	―	―	―	100
	LR1/3.5 Elevators		**Level 3.0**	**Level 0.0**	**Level 0.0**	**Level 0.0**	**Level 0.0**	**Level 0.0**	**Level 0.0**	**Input CEC value**
	weight		0.05	―	―	―	―	―	―	0.05
Equipment of enhanced energy usage efficiency (*)	Energy saving by PV	MJ/yr	**3,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Energy saving by others	MJ/yr	**40,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Annual Energy Saving Volume Using Efficient Equipment (A)	MJ/yr	43,000	0	0	0	0	0	0	0
	Annual Energy Saving for the Entire Building (B)	MJ/yr	**11,869,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Energy Saving rate K value A/B		0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ERR	Choice of method (single use)			Assessment by ERR						
	Weighted score from scores of assessed systems		Level 0.0	Level 0.0	Level 0.0	Level 0.0	Level 0.0	Level 0.0	Level 0.0	Level 0.0
	ERR converted from the weighted score		0%	0%	0%	0%	0%	0%	0%	0%

	Primary energy consumption of Subject Bldg.	MJ/yr		0	337,176	0	0	0	0	0	0
	Standard primary energy consumption	MJ/yr		0	819,936	0	0	0	0	0	0

* Such as solar energy generation system and cogeneration system

ERR for Entire bldg. (excluding Apartments)	Primary energy consumption of Subject bldg.	MJ/yr	337,176
	Standard primary energy consumption	MJ/yr	819,936
	ERR (Reduction Rate of Primary energy consumption)		**58.9%**

CO2 emission related to operational energy from Reference bldg.(Standard calculation)

By Building type	Primary energy consumption	MJ/yr		0	5,225,298	0	0	0	0	0	0
	Perimeter area	m2		0	3,388	0	0	0	0	0	0
	Perimeter Annual Load	MJ/yr		0	1,084,067	0	0	0	0	0	0
	CO2 emission related to operational energy	kg-CO2/yr		0	296,173	0	0	0	0	0	0
Entire building	Primary energy consumption	MJ/yr	5,225,298								
	CO2 emission related to operational energy	kg-CO2/yr	**296,173**								

CO2 emission related to operational energy from Subject bldg.(Standard calculation)

By Building type	Assessment by ERR			0%	59%	0%	0%	0%	0%	0%	0%
	Perimeter Annual Load	MJ/yr		0	877,417	0	0	0	0	0	0
	Use of natural energy (excluding PV)	MJ/yr	Level 3	(3,000)	0	0	0	0	0	0	0
	Saving by efficient operation		Level 3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Primary energy consumption of Subject Bldg.	MJ/yr		3,000	2,021,290	0	0	0	0	0	0
	CO2 emission related to operational energy	kg-CO2/yr		169	114,568	0	0	0	0	0	0
Entire building の	Primary energy consumption	MJ/yr	2,024,290								
	CO2 emission related to operational energy	kg-CO2/yr	**114,737**								

CO2 emission related to operational energy from Apartments(Standard calculation)

■ Primary energy consumption condition for each building type

Primary energy consumption	MJ/m²–yr		1,936	1,209	3,225	2,923	2,212	330	2,399	2,918

■ Conversion from qualitative assessment to quantitative assessment

LR1/1.Building Thermal Load		MJ/m²–yr	Level 1	330	352	418	605	605	0	374	462	150%
Other than Apartments	Conversion from Point value		Level 2	315	336	399	578	578	0	357	441	125%
	to PAL value		Level 3	300	320	380	550	550	0	340	420	100%
	Reduction of Heating		Level 4	270	288	342	495	495	0	306	378	—

Apartments										
	Level 5	225	240	285	413	413	0	255	315	69%
LR1/2.Natural Energy Utilization MJ/m^2–yr	Level 1	0	0	0	0	0	0	0	0	—
Other than Apartments Estimated reduction of Primary energy consumption	Level 2	0	0	0	0	0	0	0	0	110%
LR1/2.1 Direct Use of Natural Energy	Level 3	0	0	0	0	0	0	0	0	100%
Apartments Reduction of energy for Cooling	Level 4	1	1	1	1	1	1	1	1	90%
	Level 5	20	20	20	20	20	20	20	20	80%
LR1/3.Efficiency in Building Service System	Level 1	-10%	-10%	-10%	-10%	-10%	-10%	-10%	-10%	110%
Other than Apartments Conversion from Point value	Level 2	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	105%
to PAL value	Level 3	0%	0%	0%	0%	0%	0%	0%	0%	100%
Apartments Reduction of energy for Common areas	Level 4	10%	10%	10%	10%	10%	10%	10%	10%	90%
(Ventilation System * Lighting System * Elevators)	Level 5	25%	25%	25%	25%	25%	25%	25%	25%	75%
LR1/3.4.Hot Water Supply System	Level 1									—
Apartments Reduction of Hot water supply	Level 2									117%
Individual supply system	Level 3									100%
	Level 4									83%
	Level 5									71%
LR1/4.Efficient Operation	Level 1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	110%
Other than Apartments Correction coefficients for CO2 from operational energy	Level 2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	105%
LR1/3.4.Hot Water Supply System	Level 3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	100%
Apartments Reduction of Hot water supply	Level 4	0.975	0.975	0.975	0.975	0.975	0.975	0.975	0.975	90%

	Level 5	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	75%

Q3 Outdoor Outside Environment on Site

Select from pull-down menus or enter figures and comments.

1 Preservation & Creation of Biotope

Weighting coefficients (default)= 0.30

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	No consideration has been give to the conservation and creation of habitat, and effort is inadequate. (0~3 points)
Level 2	Some consideration has been give to the conservation and creation of habitat, but effort is still somewhat inadequate. (4~6 points)
■Level 3	Consideration has been give to the conservation and creation of habitat, and a standard level of effort has been made. (7~9 points)
Level 4	Consideration has been give to the conservation and creation of habitat, and a relatively large number of efforts have been made. (10~12 points)
Level 5	Thorough consideration has been give to the conservation and creation of habitat, and extensive efforts have been made. (13 or more points)

Efforts to be evaluated

Point	Item	Evaluated Content	Evaluated Point
1 Point	I. Identification of site characteristics and setting of planning policies	1) Site characteristics related to habitats including the site and its surroundings have been identified.	1
1 Point		2) Planning policies related to conservation and creation of habitat on the basis of site characteristics have been stated.	1
1 Point	II. Conservation of biological resources	1) Biological resources such as flora and fauna, topsoil and waterside areas on the site have been conserved.	1
1 Point		2) Biological resources such as flora and fauna, topsoil and waterside areas previously existing on the site have been restored (regenerated).	1
1 Point	III. Securing quantity of foliage	1) Greenery covers 10% or more, but less than 20% of exterior area, and medium and tall trees have been planted (1 point)	1~3

		Greenery covers 20% or more, but less than 50% of exterior area. (2 points) Greenery covers 50% or more of exterior area. (3 points)	
1 Point		2) Building planting brings the building planting index to 0.05 or more, but less than 0.2. (1 point) Building planting brings the building planting index to 0.2 or more. (2 point)	1~2
1 Point	IV. Securing quality of foliage	1) Foliage has been generated that is appropriate for the planting conditions of the plot and the building.	1
0 Point		2) Foliage has been generated that considers securing living habitat for small wild animals.	1
0 Point		3) Foliage has been generated that considers preservation of local species.	1
0 Point	V. Management and use of habitat	1) Equipment necessary for the maintenance management of green areas at the building operation stage have been installed, and management policies have been set.	1
0 Point		2) An environment and facilities have been provided in which building users and local people can encounter natural organisms and get closer to nature.	1
0 Point	VI. Other	Independent efforts other than the above evaluated items have been made to conserve and create habitat.	1
Total =	**7 Point**		

2 Townscape & Landscape

Weighting coefficients (default)=	0.40

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	The building impairs the scenery, blocks views, is too tall, or otherwise infringes scenic benefits* from scenery that is symbolic of the area, such as castles, mountains, sea or street scenery.
Level 2	Efforts for the benefit of the surrounding streets and scenery are lacking. (+1 or less assessment points)
■Level 3	Efforts for the benefit of the surrounding streets and scenery are at a standard level. (+2~3 assessment points)

Level 4	Efforts for the benefit of the surrounding streets and scenery are above the standard level. (+4 assessment points)
Level 5	Efforts for the benefit of the surrounding streets and scenery are thorough and extensive. (+5 or more assessment points, or the building has been awarded prizes related to urban appearance and scenery).

Level 3.0	← Direct input	

[1] Evaluate level three if the building is almost entirely unseen from public spaces, or if there is no way to give consideration to urban context and scenery.
[2] If there are independent rules for the area (urban context guidelines etc.), and efforts have been made on that basis, evaluate the content of such efforts.
[3] Evaluate level five if scenery is clearly stated as a reason for winning a local scenery prize, or any similar situation indicating the building has gained a certain level of positive assessment.

Efforts to be evaluated

Point	Item	Evaluated Content	Evaluated Point
	I. Infringing scenic benefits	1) The building inhibits the scenery, blocks views, is too tall, or otherwise infringes scenic benefits* from scenery that is symbolic of the area, such as castles, mountains, sea or street scenery.	
0 Point		2) Lack of harmony with surrounding streets and scenery The building has an oppressive influence on part of the surrounding urban context, or has a layout, height, visual volume, color, boundary walls or other elements that clash with the scenery.	-2
1 Point	II. Formation of favorable scenery	3) Formation of favorable scenery from the perspective of important viewpoints in the surroundings. Efforts have been made to form good scenery from important viewpoints where the general public gather nearby, such as parks and station plazas.	1
1 Point		4) The positioning and form etc. of the building is in harmony with nearby urban context. The adjustment, height, coloration and other aspects of the roof, exterior cladding, eaves, fences and walls reduce the sense of oppressiveness on the surroundings, achieving a well-balanced harmony.	1
1 Point		5) Use of green space to form good scenery Green space has been provided in order to form good scenery.	1
0 Point		6) Formation of good scenery with materials of local character Exterior cladding materials of local character are used to form good scenery.	1

0 Point		7) Continuation of historic scenery Historic buildings and objects and existing plants, topography, springs etc. are conserved, restored or regenerated to carry on the historic character of local scenery.	1
0 Point		8) Formation of a new symbol in the urban scenery The building gives the urban scenery a new symbol, thereby helping to stimulate it.	1
0 Point		9) Other (State content)	1
Total =	**3 Point**		

* "Scenic benefits" refers to enjoying the pleasures of good scenery. Judgments of infringement of scenic benefits should be limited to cases in which disputes have arisen over scenery. In the appeal judgment (2006.3.30) on the legal action brought by local residents against a 14-story condominium (44m tall) on University Avenue, Kunitachi City, the Supreme Court stated that "it (scenery) has objective value in cases where it forms an historic or cultural environment and is an element in a rich way of life", and that "those residing in areas adjoining favorable scenery have the advantage of benefiting from good scenery (scenic benefits), which merits legal protection." That was the first judgment recognizing the scenic benefits of local residents.

3 Local Characteristics & Outdoor Amenity

3.1 Attention to Local Charcter & Improvement of Comfort

Weighting coefficients (default)=	0.50

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	No efforts have been made for local characteristics and outdoor amenity (0 points)
Level 2	Efforts based on local characteristics and outdoor amenity are inadequate. (+1 point)
■Level 3	Efforts based on local characteristics and outdoor amenity are at a standard level.(+2~3 points)
Level 4	Efforts based on local characteristics and outdoor amenity are at a relatively high level.(+4 points)
Level 5	Efforts based on local characteristics and outdoor amenity are thorough and extensive.(+5 or more points)

Efforts to be evaluated

Point	Item	Evaluated Content	Evaluated Point

1 Point	I. Continuation of region-specific scenery, history and culture	1) Conservation of historic built spaces etc. Historic interior and exterior spaces building remains preserved, restored or regenerated, contributing to local culture. (Do not evaluate if measures here overlap with areas evaluated under urban context and scenery).	1
0 Point		2) Use of materials with regional character Materials of regional character are used for some of the building's structure, internal finishes or exterior spaces.	1
1 Point	II. Local contribution through provision of functional spaces and facilities	3) Local contribution by provision of space Structural measures such as provision of alcoves, piloti and eaves are used to provide amenity for people using urban spaces, in the form of places to shelter from rain or wait for people. Or, Space is provided in plazas, paths and side streets to provide amenity for people using the local area, in the form of rest areas and similar spaces.	1
0 Point		4) Local contribution by provision of facilities and functions Part of the building is equipped to provide public facilities and functions, such as meeting rooms, community halls and exhibition spaces, community centers, and community use of schools, contributing to greater activity in the community.	1
0 Point	III. Formation of rich intermediate zones linking the building interior and exterior	5) Formation of rich intermediate zones linking the building interior and exterior Open spaces that allow the passage of wind and light, such as courtyards, terraces, balconies, sun rooms, roofed plazas, light and air voids, and atria are skillfully linked to interior spaces. Or, In areas where private and public spaces intersect, such as around entrances and balconies, light and air voids, flower beds, pergolas, deep balconies and similar elements have been built to form rich intermediate spaces which give a lived-in atmosphere.	1
0	IV. Consideration for	6) Consideration for crime prevention	1

Point	crime prevention	Crime prevention performance is considered, so that in spaces outside the building, such as plazas, trees are placed to avoid blocking lines of sight, nocturnal lighting and security cameras are installed, windows are placed where they will be useful for crime prevention, and other measures are used. Or, If there are no plazas or pedestrian walkways, consideration is given to crime prevention in the form of avoiding the creation of blind spots, such as blind alleys and paths out of lines of sight, placing windows where they will be useful for crime prevention, and other measures. Or, If there are boundary barriers around the site, crime and disaster prevention are considered, in the form of fences or low hedges which afford clear lines of sight, rather than continuous walls or similar barriers which block lines of sight.	
0 Point	V. Participation of building users etc.	7) Participation of building users etc. User satisfaction assessments (POE) are used to involve building users in the design process for cooperative housing etc. Or, Residents and occupants work directly on plant management and cleaning activities and formulate operation plans, and are otherwise participating in the maintenance management of the building.	1
0 Point	VI. Other	8) Other (State content)	1
Total =	**2 Point**		

3.2 Improvement of the Thermal Environment on Site

Weighting coefficients (default)=	0.50

Level 3.0	Off, Sch, Rtl, Rst, Hal, Apt, Hsp, Htl, Fct
Level 1	0 points in the table of the efforts to be evaluated
Level 2	1~4 points in the table of the efforts to be evaluated
■Level	5~9 points in the table of the efforts to be evaluated

3	
Level 4	10~14 points in the table of the efforts to be evaluated
Level 5	15 points or more in the table of the efforts to be evaluated.

Efforts to be evaluated

Point	Item		Evaluated Content	Evaluated Point
2 Point	Reduction of thermal impact on people on-site	1) Guide wind into the site to relieve the thermal environment	[1] The planned form and layout of buildings guides wind onto the plot.	2
2 Point			[2] Secure paths for air movement by providing green spaces of lawn, meadow and bushes etc., and suitable spaces and paths within the plot. Open space ratio is 40% or more, less than 60% (1 point) 60% or more, less than 80% (2 points) 80% or more (3 points)	1~3
1 Point		2) Provide green space, water surfaces and other elements within the site to alleviate the thermal environment.	[1] Create of shade by the use of green space with medium and tall trees, piloti, eaves, pergolas and similar measures. Share of projected horizontal area used for green space, piloti, etc. 10% or more, less than 20% (1 point) 20% or more, less than 30% (2 points) 30% or more (3 points)	1~3
0 Point			[2] Provide green areas of lawn, meadow or shrubbery etc., or open water, to limit the rise in ground temperature, and in air temperature near the ground. Share of projected horizontal area used for green space, piloti, etc. 10% or more, less than 20% (1 point) 20% or more, less than 30% (2 points) 30% or more (3 points)	1~3
0			[3] Endeavor to reduce the area of paving on the plot.	1~3

Point			Percentage of paved area is 20% or more, less than 30% (1 point) 10% or more, less than 20% (2 points) Less than 10% (3 points)	
2 Point		3) Consider the positioning of air and heat venting from construction equipment to relieve the thermal environment.	[1] Prevent waste air and heat from affecting areas people pass through and air intake areas.	2
2 Point			[2] Decide heat venting areas with consideration of air movement paths and heat dispersal on the site.	2
Total =	**9 Point**			

LR1 Energy

Select from pull-down menus or enter figures and comments.

1 Building Thermal Load

Weighting coefficients (default)= 0.30

	Off, Sch, Rtl, Rst, Hal, Hsp, Htl		Apt
Level 4.0	Assessment using the performance standards (PAL value)	Assessment using the specification standards (Point value) (new buildings with total floor area under 5,000m2)	For apartments, evaluate insulation performance and shading performance as before, according to the current Energy Saving Law and the Japan Housing Performance Standard under the Housing Quality Assurance Law which is based on it, and also the passive systems applied, such as outside air loads and direct gains, under the Building Thermal Load items.
Level 1	Compared to the standard value, 5% < [PALvalue]	[Point value] < 80pts	Corresponding to grade 1 of the Japan Housing Performance Standard “5-1 Energy-saving Countermeasure Grade.”

Level 2	Compared to the standard value, 0% < [PALvalue] =< 5%	80 pts =< [Point value] < 100 pts	Corresponding to grade 2 of the Japan Housing Performance Standard "5-1 Energy-saving Countermeasure Grade."
Level 3	Compared to the standard value, -10% < [PALvalue] =< 0%	100 pts =< [Point value] < 130 pts	Corresponding to grade 3 of the Japan Housing Performance Standard "5-1 Energy-saving Countermeasure Grade."
■Level 4	Compared to the standard value, -25% < [PALvalue] =< -10%	130 pts =< [Point value] < 160 pts	(No corresponding level)
Level 5	Compared to the standard value, [PALvalue] =< -25%	160 pts =< [Point value]	Corresponding to grade 4 of the Japan Housing Performance Standard "5-1 Energy-saving Countermeasure Grade."

Direct input

Level 3.0	

Energy Saving Countermeasure Grade under the Japan Housing Performance Standard

Annual heating and cooling load MJ/m2-yr				Subject Bldg.		Area Category VI
Zone ∗	I	II	III	IV	V	VI
Grade 1	- (Buildings that fall short of grade 2)					
Grade 2	840 or less	980 or less	980 or less	980 or less	980 or less	980 or less
Grade 3	470 or less	610 or less	640 or less	660 or less	510 or less	420 or less
Grade 4	390 or less	390 or less	460 or less	460 or less	350 or less	290 or less

∗) Other than the items above, the judgement standard contain corrected value standards for equivalent clearance area, summer solar gain coefficient and passive solar housing. (Refer to the bibliography for details)

2 Natural Energy Utilization

Apply to all types of building at the Execution Design and Construction Completion Stages other than apartments.

Weighting coefficients (default)=	1.00

Level 3.0	Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	4,322m2
Level 1	Level 1	(No corresponding level)	
Level 2	Level 2	(No corresponding level)	
■Level 3	■Level 3	0MJ/m2-yr=< [Natural energy usage] <1MJ/m2-yr *Include use for monumental purposes, as well as no natural energy usage.	
Level 4	Level 4	1MJ/m2-yr=< [Natural energy usage] <20MJ/m2-yr	
Level 5	Level 5	20MJ/m2-yr=< [Natural energy usage]	

2.1 Direct Use of Natural Energy.

Weighting coefficients (default)=	0.00

Apply to all types of building at the Preliminary Design other than apartments and to apartmets at all assessment stages.

Level	Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	4,322 m²	Level 3.0	Apt	m²
Level 1	Level 1	(No corresponding level)		Level 1	(No corresponding level)	
Level 2	Level 2	(No corresponding level)		Level 2	Light intake and natural ventilation are not possible at level 3.	
Level 3	■Level 3	Of the efforts to be evaluated, any of the methods is used, even if only partially.		■Level 3	Nearly all dwellings (at least 80%) have exterior walls on at least two sides, ensuring effective light intake and natural ventilation.	
Level 4	Level 4	Of the efforts to be evaluated, any of the methods is used in a majority of the building.		Level 4	In addition to the above, building measures, such as ventilation voids, have been used to enhance their efficacy. They influence a majority (50% or more) of residential blocks.	

Level 5	**Level 5**	Of the efforts to be evaluated, two or more of the methods are used in a majority of the building.	**Level 5**	The building measures above cover at least 80% of residential blocks.

Efforts to be evaluated Total **0** items

Judgment	NO.	Evaluated Content ＊
	1	Use of natural light: Planning for natural light systems that use sunlight in place of lighting equipment. (E.g. Light shelves, top lights, high side lights, etc.)
	2	Use of natural ventilation: Planning for the use of natural ventilation and ventilation systems that are effective in replacing the use of air conditioning equipment and reducing cooling loads. (E.g. Automatic dampers, night purging, ventilation systems linked to atria, solar chimney ventilation towers etc.)
	3	Use of geothermal energy: Planning for the use of geothermal heat usage systems that are effective in replacing the use of heat sources and air conditioning equipment and reducing heating and cooling loads. (E.g. Cool and heat tubes and pits etc.)
	4	Other : Planning for the effective use of nature in other systems.

＊) Award "yes" if they are applied to a majority of the building (50% or more of the total floor area)

2.2 Converted Use of Renewable Energy

Weighting coefficients (default)= 0.00

Level 3.0	Preliminary Design	**Level 3.0**	Execution Design and Construction Completion
	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt		Apt ㎡
Level 1	(No corresponding level)	**Level 1**	(No corresponding level)
Level 2	(No corresponding level)	**Level 2**	(No corresponding level)
■Level 3	Of the efforts to be evaluated, any of the methods is used, even if only partially.	**■Level 3**	0 MJ/m2, yr =<[Renewable energy usage]< 1MJ/m2, yr *Include planned use for monumental purposes, as well as use as energy.
Level 4	Of the efforts to be evaluated, any of the methods is used in a majority of the building.	**Level 4**	1MJ/m2, yr =<[Renewable energy usage]< 15 MJ/m2, yr
Level 5	Of the efforts to be evaluated, two or more of the methods are used in a majority of the building.	**Level 5**	15 MJ/m2, yr =<[Renewable energy usage]

Efforts to be evaluated Total **0** items

Judgment	NO.	Evaluated Content ∗
	1	Use of sunlight: Planning for solar generation systems used in place of electrical power equipment. (E.g. Solar panels etc.)
	2	Use of solar heat: Planning for effective use of solar heat systems in heating equipment to reduce heating loads. (E.g. Solar panels, vacuum-type water heaters.)
	3	Use of unused heat: Planning for effective use of unused-heat systems to improve heat source efficiency in heating equipment. (E.g. Heat pumps using well water or river water etc.)
	4	Other : Planning for the effective use of nature in other systems

∗) Award "yes" if they are applied to a majority of the building (50% or more of the total floor area)

3 Efficiency in Building Service System

Weighting coefficients (default)=	0.30

Entire Building

3a Assessment by ERR

Level 5.0		4,322 m²
	Level 5	Assessment by ERR
Level 1	Level 1	[ERR Value] < -5%
Level 2	Level 2	-5% =< [ERR Value] < 0%
Level 3	Level 3	0% =< [ERR Value] < 10%
Level 4	Level 4	10% =< [ERR Value] < 25%
■Level 5	■Level 5	25% =< [ERR Value]

3b Assessment by means other than ERR

	m²		m²	
	Level		Level	
	Point	Weighting coefficients (default)	Point	Weighting coefficients(default)
3.1	5			
3.2			Input CEC value	
3.3	5		Input CEC value	
3.4			Input CEC value	
3.			Input CEC value	

5				

The levels after correction by "K", energy saving rate.

3.1 HVAC System

Weighting coefficients (default)=	Weighting coefficients(default)=			
		Off, Sch, Rtl, Rst, Hal, Hsp, Htl		Fct, Apt
Level 5	**Level**	Assessment by performance standard [CEC-AC value]	Assessment by specification standard [Point value]	
Level 1		Compared to standard value, 5% =< [CEC value]	Below the corrected points	(Excluded)
Level 2		Compared to standard value, 0% < [CEC value] <5%	Above the corrected point, and [Point value] < 100 pts	
Level 3		Compared to standard value, -10% < [CEC value] =< 0%	100 pts=< [Point value] < 130 pts	
Level 4		Compared to standard value, -25% < [CEC value] =< -10%	130 pts =< [Point value] < 160 pts	
■Level 5		Compared to standard value, [CEC value] =<-25%	160 pts =< [Point value]	

3.2 Ventilation System

Weighting coefficients (default)=	Weighting coefficients(default)=			
		Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt*		Fct
Level	**Input CEC value**	Assessment by performance standard [CEC-V value]	Assessment by specification standard [Point value]	
	#VALUE!	Compared to standard value, 5% =< [CEC value]	[Point value] < 90 pts	(Excluded)

	#VALUE!	Compared to standard value, 0% < [CEC value] <5%	90 pts=< [Point value] < 100 pts	
	#VALUE!	Compared to standard value, -10% < [CEC value] =< 0%	100 pts=< [Point value] < 120 pts	
	#VALUE!	Compared to standard value, -25% < [CEC value] =< -10%	120 pts =< [Point value] < 140 pts	
	#VALUE!	Compared to standard value, [CEC value] =< -25%	140 pts =< [Point value]	

3.3 Lighting System

Weighting coefficients (default)=	Weighting coefficients(default)=		
		Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt*	
Level 5	**Input CEC value**	Assessment by performance standard [CEC-L value]	Assessment by specification standard [Point value]
Level 1	**#VALUE!**	Compared to standard value, 5% =< [CEC value]	[Point value] < 90 pts
Level 2	**#VALUE!**	Compared to standard value, 0% < [CEC value] <5%	90 pts=< [Point value] < 100 pts
Level 3	**#VALUE!**	Compared to standard value, -10% < [CEC value] =< 0%	100 pts=< [Point value] < 120 pts
Level 4	**#VALUE!**	Compared to standard value, -25% < [CEC value] =< -10%	120 pts =< [Point value] < 140 pts
■Level 5	**#VALUE!**	Compared to standard value, [CEC value] =< -25%	140 pts =< [Point value]

3.4 Hot Water Supply System

Weighting coefficients (default)=	Weighting coefficients(default)=				
Level	**Input CEC value**	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	Apt*		
	Level 3.0	Assessment by performance standard [CEC-HW value]	Assessment by specification standard [Point value]	Individual supply system	Central supply system (Assessment by specification standard [Point value])
	#VALUE!	Compared to standard value, 5% =< [CEC value]	[Point value] < 90 pts	(No corresponding level)	[Point value] < 90 pts
	#VALUE!	Compared to standard value, 0% < [CEC value] <5%	90 pts=< [Point value] < 100 pts	Other than those listed below	90 Pts=<[Point value]<100 Pts
	#VALUE!	Compared to standard value, -10% < [CEC value] =< 0%	100 pts=< [Point value] < 130 pts	Electric water heaters (electric control type)	100 Pts=<[Point value]<130 Pts
	#VALUE!	Compared to standard value, -25% < [CEC value] =< -10%	130 pts =< [Point value] < 160 pts	Fuel-burning instant-supply water heaters	130 Pts=<[Point value]<160 Pts
	#VALUE!	Compared to standard value, [CEC value] =< -25%	160 pts =< [Point value]	Fuel-burning latent heat recovery instant-supply water heaters, electric CO2-refrigerant water heater (late-night electricity water storage heater)	160 Pts=<[Point value]

Reference) The relationship between individual systems and equipment primary energy consumption

Score	Standard	Compliant devices *)
2 Pts	Primary energy consumption 3.0kJ or more	Other than those listed below
3 Pts	Primary energy consumption 2.0kJ or more, less than	Electric water heaters (electric control type)

	3.0kJ	
4 Pts	Primary energy consumption 1.2kJ or more, less than 2.0kJ	Fuel-burning instant-supply water heaters
5 Pts	Primary energy consumption less than 1.2kJ	Fuel-burning latent heat recovery instant-supply water heaters, electric CO2-refrigerant water heater (late-night electricity water storage heater)

＊)If the equipment used is not among the compliant devices listed in the table, it is sufficient to evaluate on the basis of primary energy consumption calculated from the rated performance of the equipment used.

3.5 Elevators

Weighting coefficients (default)=	Weighting coefficients(default)=		
		Off, Htl, Apt*	
Level	**Input CEC value**	Assessment by performance standard [CEC-EV value]	Assessment by specification standard [Point value]
	#VALUE!	Compared to standard value, 5% =< [CEC value]	[Point value]<90 Pts
	#VALUE!	Compared to standard value, 0% < [CEC value] <5%	90 Pts=<[Point value]<100 Pts
	#VALUE!	Compared to standard value, -10% < [CEC value] =< 0%	100 Pts=<[Point value]<120 Pts
	#VALUE!	Compared to standard value, -25% < [CEC value] =< -10%	120 Pts=<[Point value]<140 Pts
	#VALUE!	Compared to standard value, [CEC value] =< -25%	140 Pts=<[Point value]

3.6 Equipments for Improving Energy Efficiency

0.0%	0.0 %

4 Efficient Operation

4.1 Monitoring

Weighting coefficients(default) =	0.50

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct
Level 1	(No corresponding level)
Level 2	(No corresponding level)
■Level 3	It must be possible to identify the annual consumption of each kind of energy used in the building and use the base unit for energy consumption, or other means, for benchmark comparison.
Level 4	Beyond level 3, the breakdown of energy consumption 1) for each major building type must be identified, trends in consumption identified and analyzed, and their appropriateness confirmed.
Level 5	Beyond level 4, the system efficiency 2) of major equipment systems must be evaluated in order to evaluate the performance of the systems.

1) Broadly, monitoring must be planned which will be able to identify the breakdown, by application, of a majority of the total energy consumption.

2) Broadly, efficiency assessment must be performed on at least three of the types listed in table 1. If there are many systems, such as air conditioning, lighting and ventilation, it is permissible to estimate the whole from the assessment of representative systems.

Table 1 Efficiency Assessment Examples

Equipment items		Assessment Items	Assessment Summary	Remarks
1	Heat source equipment	Heat source machine COP assessment	Amount of heat generated / energy consumed by the heat source (based on primary energy)	
		COP assessment of heat source systems	Amount of heat generated / energy consumed by the heat source and related equipment (based on primary energy)	Includes introduction of district heating and cooling
		Heating medium conveyance WTF	Amount of heat carried/ energy consumed by pump (based on secondary energy)	
2	Air conditioning equipment	Air conditioner conveyance ATF	Amount of heat carried/ energy consumed by fan (based on secondary energy)	
		Total enthalpy heat exchange effect	Amount of heat reduced, amount of energy	
		Cooling effect by external air	Amount of heat reduced, amount of energy	

3	Ventilation equipment	Assessment of variable air volume control		
4	Lighting equipment	Assessment of various types of control	Amount of energy saved by the use of daylight, occupant sensors, etc.	
5	Hot water supply equipment	Heat source machine COP assessment	Amount of heat generated / energy consumed by the heat source (based on primary energy)	
		COP assessment of heat source systems	Amount of heat generated / energy consumed by the heat source and related equipment (based on primary energy)	
		Heating medium transmission WTF	Amount of heat carried/ energy consumed by pump (based on secondary energy)	
6	Other	CGS assessment	Electricity generation efficiency, overall efficiency, energy saving rate	
		Assessment of high-efficiency transformers	Energy saving rate	

4.2 Operation & Management System

Weighting coefficients(default)=	0.50

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct	
	Preliminary Design	Execution Design and Construction Completion
Level 1	(No corresponding level)	No operation and management has been planned.
Level 2	(No corresponding level)	Organizations, systems or management policies have been planned for operation and management.
■Level 3	No significant moves (proposals) have been made towards an operation and management system.	In addition to level 2, there must be an organized operation and management system, designated manager.
Level 4	Basic guidelines for operation, maintenance and preservation have been planned.	In addition to level 3, target values for energy consumption in the whole buildings have been planned and presented to the building owner, based on calculation of annual energy consumption.
Level 5	In addition to the above, target values have been planned for annual energy consumption.	In addition to level 4, there must beregular verification of equipment performance during building operation, with specific actions planned for repair of malfunctions etc. (commissioning system)

LR2 Resources & Materials

1 Water Resources

1.1 Water Saving

Weighting coefficients (default)=	0.40

Level 4.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	No systems for saving water.
Level 2	(No corresponding level)
Level 3	Major faucets are equipped with water-saving valve.
■Level 4	In addition to water-saving valve, other water-saving equipment (such as flush-mimicking sound systems, water-saving toilets) is used.
Level 5	(No corresponding level)

1.2 Rainwater & Gray Water

1.2.1 Rainwater Use System — Weighting coefficients (default)= 0.67

1.2.2 Gray Water Reuse System — Weighting coefficients (default)= 0.33

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct
Level 1	(No corresponding level)	Level 1	(No corresponding level)
Level 2	(No corresponding level)	Level 2	(No corresponding level)
Level 3	No systems for using rainwater.	■Level 3	No systems for reusing gray water.
Level 4	Rainwater is used.	Level 4	Gray water is reused.
■Level 5	Rainwater usage brings the rainwater usage rate to at least 20%.	Level 5	In addition to gray water reuse, there is equipment to reuse sewage.

$$\text{Rainwater usage rate} = \frac{\text{Predicted rainwater usage volume}(m^3)}{\text{Total predicted water usage (mains water + rainwater use)}(m^3)}$$

2 Reducing Usage of Non-renewable Resources

2. Reducing Usage of Materials

1

Weighting coefficients (default)=	0.07

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	Major structural elements are made of non-wood materials (RC/ SRC/ S), and earned 0 point or more in the table of the efforts to be evaluated.
■Level 3	Major structural elements are made of non-wood materials (RC/ SRC/ S), and earned 1 point or more in the table of the efforts to be evaluated.
Level 4	Major structural elements are made of non-wood materials (RC/ SRC/ S), and earned 3 points or more in the table of the efforts to be evaluated.
Level 5	Major structural elements are made of non-wood materials (RC/ SRC/ S), and earned 5 points or more in the table of the efforts to be evaluated.

Efforts to be evaluated

Point	Item	Evaluated measures	Point
0 Point	<Concrete strength and main reinforcement bar strength in major structural elements>	Fc= 36 or more, but less than 60 N/mm2, and SD390 N/mm2	1
		Fc= 60 or more, but less than 100 N/mm2, and SD490 N/mm2	2
		Fc= 100 or more, and SD590 N/mm2 or more	3
1 Point	<Steel frame strength of major structural elements>	490 (N/mm2)	1
		520, 550(N/mm2)	2
		590 (N/mm2) or more	3
0 Point	<Other measures related to major structural elements>	Use of pre-stressed concrete (which reduces material cross section, thereby reducing materials used.	1
		Equivalent measures.	1
Total=	**1Point**		

2.2 Continuing Use of Existing Building Skeleton etc.

Weighting coefficients (default)=	0.24

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	(No corresponding level)
■Level 3	The existing building skeleton is not reused, or there is no existing building on the site to use.
Level 4	The existing building skeleton is partially reused.
Level 5	The existing building skeleton is completely reused.

2.3 Use of Recycled Materials as Structural Frame Materials

Weighting coefficients (default)=	0.20

Level 4.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Remarks
Level 1	(No corresponding level)	Record the recycled materials if Level 4 or avove
Level 2	(No corresponding level)	
Level 3	Major structural elements are made of non-wood materials (RC/ SRC/ S), and no recycled materials are used in major structural elements.	
■Level 4	Major structural elements are made of non-wood materials (RC/ SRC/ S), and one type of recycled materials is used in major structural elements.	
Level 5	Major structural elements are made of non-wood materials (RC/ SRC/ S), and two or more types of recycled materials are used in major structural elements.	

If the product is recognized as both an Eco Mark Product and a Specified Procurement Item, count it as one type.

Record the recycled materials and the parts where tyey are used in about 10 wards	XXXX

Examples of recycled materials

Material name	
Green procurement items (public works)	
Blast furnace slag aggregate	Blast furnace cement (concrete)

	Ferronickel slag aggregate	FA cement (concrete)
	Copper slag aggregate	Eco cement (concrete)
	Electric furnace oxidized slag aggregate	
Construction products using recycled materials that have been awarded the Eco Mark (Eco Mark product type 123)		
	Cement	

The list of recognized recycled materials is constantly updated, so check the site below before assessing

- Law on Promoting Green Purchasing designated procurement item information system (http://www.env.go.jp/policy/hozen/green/g-law/gpl-db/material.html)

- General information site for Eco Mark products (the Japan Environment Association) (http://www.greenstation.net/)

2.4 Use of Recycled Materials as Non-structural Materials

Weighting coefficients (default)=	0.20

Level 4.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Remarks
Level 1	No recycled materials are used.	Record the recycled materials if Level 3 or above
Level 2	(No corresponding level)	
Level 3	One type of recycled material used.	
■Level 4	Two types of recycled material used.	
Level 5	Three or more types of recycled material used.	

If the product is recognized as both an Eco Mark Product and a Specified Procurement Item, count it as one type.

Record the recycled materials and the parts where tyey are used in about 10 wards	

Examples of recycled materials

Material name		
Green procurement items		
	Recycled soil processed from construction sludge	Thinned lumber
	Granulated blast furnace slag for earthworks	Blast furnace cement (soil cement)

	Caisson filler using copper slag	FA cement (soil cement)
	Caisson filler using ferronickel	Eco cement (soil cement)
	Steelmaking slag for ground improvement	Sprayed concrete using FA
	Recycled heated asphalt mixtures (recycled by the user)	Paving blocks (fired) using recycled materials
	Recycled heated asphalt mixtures (other)	Paving blocks (precast, non-reinforced concrete) using recycled materials
	Asphalt mixtures with added ferrous slag (recycled by the user)	Dust shield sheets using recycled materials
	Asphalt mixtures with added ferrous slag (other)	Ceramic tile
	Use of recycled structural members as roadbed material	Lumber
	Use of recycled structural members as embankment material	Laminated wood
	Roadbed material with added ferrous slag	Particle board
		Wooden-type cement panels
Tiles and blocks that have been awarded the Eco Mark (Eco Mark product type 109)		
	Tile	Bric k
	Block	
Boards using wood materials that have been awarded the Eco Mark (Eco Mark product type 111)		
	Fiber board	Particle board
Products using thinned lumber, reused and unused materials, etc. that have been awarded the Eco Mark (Eco Mark product type 115)		
	Outdoor materials (Civil engineering and construction materials: Small logs)	Interior materials (Doors)
	Exterior materials (Civil engineering and construction materials: Laminated wood)	Outdoor materials (Columns)
	Exterior materials (Civil engineering and construction materials: Plywood)	Outdoor materials (Beams)
	Exterior materials (Exterior)	Outdoor materials (Foundations)
	Interior materials (Floor materials)	Activated carbon (for moisture regulation)
	Interior materials (Wall materials)	Activated carbon (for water purification)

	Interior materials (Sliding door frames)	Soil improvement materials
Construction products (for interior decorating finishes) that have been awarded the Eco Mark (Eco Mark product type 123)		
	Wood flooring	Thermal insulation
	Paper screens and sliding partitions	Acoustic absorption materials and anti-vibration mats
	Paper to cover paper screens and sliding partitions	Vinyl floor covers
	Board	Staircase anti-slip treatment
	Tatami matting	Braille nails
	Wallpaper	Accordion doors
Construction products (cladding and exterior parts and materials) that have been awarded the Eco Mark (Eco Mark product type 137)		
	Roofing	Plastic decking materials
	Roof materials	Composite materials of recycled wood and plastic
	Cladding materials	Rainwater storage tanks
Construction products (material-type parts and materials) that have been awarded the Eco Mark (Eco Mark product type 138)		
	Construction stone	Sumps for residential land
	Hard PVC pipes for drainage and ventilation	
Construction products (equipment) that have been awarded the Eco Mark (Eco Mark product type 139)		
	Residential bathroom units	Waterproof pans

The list of recognized recycled materials is constantly updated, so check the site below before assessing.

- Law on Promoting Green Purchasing designated procurement item information system (http://www.env.go.jp/policy/hozen/green/g-law/gpl-db/material.html)
- General information site for Eco Mark products (the Japan Environment Association) (http://www.greenstation.net/)

2.5 Timber from Sustainable Forestry

Weighting coefficients (default)=	0.05

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Remarks
Level 1	(No corresponding level)	Exclude if no timber is used.
Level 2	Timber from sustainably managed forests is not used.	
■Level 3	Timber from sustainably managed forests supplied less than 10% of timber usage, or no timber is used, even in the structural skeleton.	
Level 4	Timber from sustainably managed forests supplies 10~50% of timber usage.	
Level 5	Timber from sustainably managed forests supplies 50% or more of timber usage.	

2.6 Efforts to Enhance Reusability of Components and Materials

Weighting coefficients (default)=	0.24

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	(No corresponding level)
Level 3	No measures, as the efforts to be evaluated, to encourage recycling of materials on demolition has been used.
Level 4	One point or more of measures, as the efforts to be evaluated, to encourage recycling of materials on demolition has been used.
■Level 5	Two point or more of measures, as the efforts to be evaluated, to encourage recycling of materials on demolition have been used.

Efforts to be evaluated Total 3 items

Point	Efforts
yes	The structure of finishing materials can be separated easily.
yes	Interior finishes and equipment are not entangled, and each can easily be removed separately for demolition, refurbishment and remodeling
yes	Reusable unit materials are used.

3 Avoiding the Use of Materials with Pollutant Content

3.1 Use of Materials without Harmful Substances

Weighting	0.32

	coefficients (default)=

Level 5.0	Off - Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	(No corresponding level)
Level 2	(No corresponding level)
Level 3	There is no building material category (indicated in Reference 1) without substances specified in the Pollutant Release and Transfer Register Law. Or the inspection has not been carried out.
Level 4	There is are 1~3 building material category (indicated in Reference 1) without substances specified in the Pollutant Release and Transfer Register Law.
■Level 5	There is are 4 or more building material category (indicated in Reference 1) without substances specified in the Pollutant Release and Transfer Register Law.

Building materials to be evaluated Total **10** items

Use of substances specified in the PRTR	Category	Building materials
Non	Adhesives	For vinyl tile floors and seating
Non		For tile
		For wallpaper
Non		For floor board
	Sealants	For sash
Non		For glass
Non		For tile joint
Non		For wall joint
	Waterproofing materials	Primer for waterproofing
		For paint (surface coating)
Non	Paints	For fittings (wooden and metal)
Non		For wooden parts (frames for floor and ceiling)
Non		For structural materials
Non		For walls
	Anti-corrosion treatment	For skeleton
		For materials other than skeleton

	Undercoats	For materials for coated floors
	Floor coverings	For finishing wax
	Preservatives	For wooden parts

3.2 Avoidance of CFCs and Halons

3.2.1 Fire Retardant

Weighting coefficients (default)= 0.33

Level 4.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Remarks
Level 1	Halon fire retardant is used.	Exclude from assessment if there is absolutely no fire-extinguishing equipment, or only sprinklers.
Level 2	(No corresponding level)	
Level 3	Only used in "Critical-uses."	
■Level 4	No halon fire retardant is used.	
Level 5	(No corresponding level)	

3.2.2 Insulation Materials

Weighting coefficients (default)= 0.33

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt
Level 1	Insulation foaming materials with OPD= 0.2 or above are used.
Level 2	Insulation foaming materials with OPD= 0.01~0.2 are used.
■Level 3	Insulation foaming materials with OPD= 0.0~0.01 are used.
Level 4	(No corresponding level)
Level 5	Insulation foaming materials with ODP=0 and low GWP (less than 50), or natural materials are used. Or, no expanded insulation materials are used.

3.2.3 Refrigerants

Weighting coefficients (default)= 0.33

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Fct, Apt	Remarks
Level 1	(No corresponding level)	Exclude

Level 2	HCFC is used as the refrigerant.	from assessment if no refrigerant gases are used.
■Level 3	Refrigerant of ODP=0 is used as the refrigerant.	
Level 4	Natural refrigerants and new chilling systems (ODP=0) with GWP less than 50 are used.	
Level 5	(No corresponding level)	

Reference) Critical-uses for which halon fire retardants may be used. (Prevention Notification No.155, Hazard Notification No.61, 16th May 2001)

Types of facility		Examples of facility
Communications equipment etc.	Communications equipment rooms etc.	Communications equipment rooms, wireless equipment rooms, telephone exchange rooms, magnetic disk rooms, computer rooms, telex rooms, telephone exchange switching rooms, communications equipment control rooms, data print rooms
	Broadcasting studios etc.	TV relay rooms, remote centers, studios, lighting control rooms, musical equipment rooms, adjustment rooms, monitor rooms, broadcasting equipment rooms
	Control rooms etc.	Electrical power control rooms, operation rooms, control rooms, management rooms, disaster prevention centers, dynamometer rooms
	Film storages etc	Film storage rooms, lighting control rooms, relay desks, VTR rooms, tape rooms, projector rooms, tape storerooms
	Measurement equipment rooms in hazardous material handling facilities	Measurement equipment rooms in hazardous material handling facilities
Historical assets	Exhibition rooms etc.	Important cultural assets, artwork repositories, exhibition rooms, showrooms
Other	Workshops etc.	Print rooms containing rotary presses

Reference1) Foaming agents used in expanded plastic insulating materials

Types of expanded insulation materials	Period of use	Foaming agent name	ODP	GWP (100-year value)
Urethane foam	Before 1995	CFC - 11	1	4000
	Start of 2000s	HCFC - 141b	0.11	630
Urethane modified isocyanurate foam	Next generation	HFC - 134a	0	1300

		HFC - 245fa	0	560
		Cyclopentane C5H10	0	3
Styrene Olefin foam	Before 1995	CFC - 12	1	8500
	Start of 2000s	HCFC - 142b	0.065	2000
	Next generation	HFC - 134a	0	1300
Phenol foam	Before 1995	CFC - 113	0.8	5000
	Since 2000	Dichloromethane CH2Cl2	0	

Reference 2) ODP and GWP values of foaming gases

Substance	Persistence in atmosphere	ODP (CFC standard)	GWP(CO2 standard)		
			20yrs.	100yrs.	500yrs.
CFC - 11	50	1	5000	4000	1400
CFC - 12	120	1	7900	8500	4200
CFC - 113	85	0.8	5000	5000	2300
CFC - 114	300	1	6900	9300	8300
CFC - 115	1700	0.6	6200	9300	13000
HCFC - 22	13.3	0.055	4300	1700	520
HCFC - 123	1.4	0.02	300	93	29
HCFC - 124	5.9	0.022	1500	480	150
HCFC - 141b	9.4	0.11	1800	630	200
HCFC - 142b	19.5	0.065	4200	2000	630
HCFC - 225ca	2.5	0.25	550	170	52
HCFC - 225cb	2.6	0.033	1700	530	170
HFC - 23	264	0	9100	11700	9800

HFC - 32	5.6		2100	650	200
HFC - 125	32.6		4600	2800	920
HFC - 134a	14.6		3400	1300	420
HFC - 143a	48.3		5000	3800	1400
HFC - 152a	1.5		460	140	42
HFC - 227ea	36.5		4300	2900	950
HFC - 236fa	209		5100	6300	4700
HFC - 245ca	6.6		1800	560	170
FC - 14	50000	0	4400	6500	10000
FC - 116	10000		6200	9200	14000
FC - 218	2600		4800	7000	10000
FC - C318	3200		6000	8700	12000

LR3 Off-site Environment

1 Consideration of Global Warming

Weighting coefficients(default)= 0.33

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	Lifecycle CO2 emission rate is 125% or more of the reference value.
Level 2	
Level 3	Lifecycle CO2 emission rate is 100% of the reference value.
Level 4	
■Level 5	Lifecycle CO2 emission rate is 75% or less of the reference value.

Lifecycle CO2 emission rate kg-CO2/m2-yr

	Construction	Repair, Renewal and Demolition	Operation	Total	
Reference	10.24	16.68	68.53	95.45	100 %
Subject	10.24	16.68	26.55	53.47	**56%**

Converted score from Lifecycle CO2 emission rate

Converted score = **5.0**

2 Consideration of Local Environment

2.1 Air Pollution

Weighting coefficients(default)=	0.25

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	Gas and dust concentrations at sources of NOx, SOx and dust exceeds the emission standards set by the Air Pollution Control Law, the NOx emission guidelines for small combustion equipment (Ministry of the Environment) or local ordinances.
Level 2	(No corresponding level)
Level 3	Gas and dust concentrations at sources of NOx, SOx and dust are reduced to below the emission standards set by the Air Pollution Control Law, the NOx emission guidelines for small combustion equipment (Ministry of the Environment) or local ordinances.
Level 4	Gas and dust concentrations at sources of NOx, SOx and dust are considerably reduced to below the emission standards set by the Air Pollution Control Law, the NOx emission guidelines for small combustion equipment (Ministry of the Environment) or local ordinances.
■Level 5	No incineration equipment is used, and absolutely no atmospheric pollutants leave the hypothetical closed space of the building to the outside.

2.2 Heat Island Effect

Weighting coefficients(default)=	0.50

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	0 points in the table of the efforts to be evaluated
Level 2	1~5 points in the table of the efforts to be evaluated
Level 3	6~10 points in the table of the efforts to be evaluated
Level 4	11~17 points in the table of the efforts to be evaluated
■Level 5	18 points or more in the table of the efforts to be evaluated .

Efforts to be evaluated

Points	Item		Evaluated Content	Evaluated Point
0 Point	I. Preliminary investigation of heat environment	1) Preliminary investigation of the local heat environment	[1] Existing data such as data from nearby meteorological stations and regional meteorological observation data (AMEDAS data) was used to identify the wind environment, including directions, speeds and prevailing direction.	1~2

			[2] In addition to [1] above, on-site measurements were taken, or a supplementary detailed investigation was performed using a wide-area environmental forecasting system based on wide-area meteorological data and topographical data. (2 points)	
2 Point	II Countermeasures to reduce thermal impact beyond the site	2) Consider wind movement to downwind areas, and reduce thermal impact beyond the site	[1] Reduce the elevation area of the building facing the prevailing summer wind direction (the most common wind direction) If the elevation area is 50% or more, but less than 70% (1 point) 30% or more, less than 50% (2 points) Less than 30% (3 points)	1~3
3 Point			[2] Secure building setback distance and spacing from adjacent buildings prevailing summer wind direction (the most common wind direction) The setback ratio from the site boundary, relative to the building height (or the ratio between building height and spacing between blocks if there are multiple blocks is 0.2 or more, but less than 0.3% (1 point) 0.3 or more, but less than 0.4% (2 points) 0.4 or more (3 points)	1~3
2 Point		3) Create shade to reduce thermal impact beyond the site	[1] Create shade by the use of green space with medium and tall trees, piloti, eaves, pergolas and similar measures. horizontal projected area ratio of medium and tall trees, piloti etc. is 10% or more, but less than 20% (1 point)	1~3

			20% or more, but less than 30% (2 points) 30% or more (3 points)	
3 Point		4) Consider ground surface coverage to reduce thermal impact beyond the site	[1] Use surface covering materials of high water retention or permeability, or of high solar reflectance, on the ground surface (ground surface covering materials: water-retentive or water-permeable paving, or highly solar reflective) Area ratio of water-retentive or water-permeable paving is 5% or more, but less than 10% (1 point) 10% or more, but less than 15% (2 points) 15% or more (3 points)	1~3
3 Point		5) Consider the building cladding materials to reduce thermal impact beyond the site	[1] Try rooftop planting. Alternatively, select roofing materials of high solar reflectance or high emittance of long wavelengths (roofing materials) Area ratio of roof planting etc. is Partially used, but less than 20% (1 point) 20% or more, less than 40% (2 points) 40% or more (3 points)	1~3
3 Point			[2] Try wall planting. Alternatively, select exterior wall materials of high solar reflectance or high emittance of long wavelength (wall materials) Area ratio of wall planting etc. is Partially used, but less than 20% (1 point) 20% or more, but less than 40% (2 points) 40% or more (3 points)	1~3

2 Point		6) Reduce atmospheric emission of heat from building equipment	[1] Devise suitable countermeasures, such as limiting building thermal loads, using energy efficiently, and making use of natural and unused energy (restriction of thermal loads, energy use) If building thermal loads are restricted, energy is used efficiently, and natural and unused energy are used, etc. (2 points)	2
0 Point			[2] Try to reduce air temperature rise through measures such as keeping the temperature of waste heat from building equipment low (reduction of waste heat temperature) Effective measures have been used to restrict air temperature rise. (2 points)	2
1 Point	III. Confirmation of effects	7) Use simulations or other means to confirm effects in mitigating deterioration of the heat environment	[1] Building form and positioning, relative to wind direction, were considered at the desk plan stage (desktop prediction). (1 point)	1~2
			[2] Numerical simulation of fluid flow, or other methods, were used on the current situation and the planned building, considering topography of the site area, the building and surrounding green space, to predict impact. (2 points)	
Total=	**19 Point**			

2.3 Load on Local Infrastructure

2.3.1 Reduction of Rainwater Discharge Loads

		Weighting coefficients(default)= 0.25
Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct	
	If there are administrative guidelines	If there are no administrative guidelines

Level 1	(No corresponding level)	Exclude
Level 2	(No corresponding level)	
■Level 3	Rain water flow suppression measures are implemented at the instructed scale.	
Level 4	The instructed scale is satisfied, and other rain water treatment measures have been implemented.	
Level 5	(No corresponding level)	

2.3.2 Sewage Load Suppression

Weighting coefficients(default)=	0.25

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	(No corresponding level)
Level 2	(No corresponding level)
■Level 3	The Water Pollution Control Law, the Sewerage Law or the discharge standards set by local authorities etc., whichever is the most stringent, is satisfied.
Level 4	Discharge standards are satisfied, and further special measures have been used for better control of sewage loads.
Level 5	(No corresponding level)

2.3.3 Traffic Load Control

Weighting coefficients(default)=	0.25

Level 2.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	0 points in the table of the efforts to be evaluated
■Level 2	1 point in the table of the efforts to be evaluated
Level 3	2 points in the table of the efforts to be evaluated
Level 4	3 points in the table of the efforts to be evaluated
Level 5	4 points or more in the table of the efforts to be evaluated

Efforts to be evaluated

Point	Item	Evaluated Content	Point
1 Point	*I. Efforts related to use of bicycles (use of alternative means of transport)*	1) Provision of an appropriate number of cycle parking spaces (including motorcycle spaces) for building users, and consideration for the convenience of cycle park	1

		users (ease of entry and egress, placement in a convenient location, etc.).	
Excluded		2) Other (state content)	1
0 Point	II .Efforts to provide car parking space	1) Provision of an appropriate number of car parking spaces (as a measure to avoid parking on roads, and congestion of nearby roads).	1
0 Point		2) Provision of parking facilities for unloading goods vehicles (residential buildings are not applicable).	1
0 Point		3) Consideration of the position, form and number of parking lot approach roads (entry and exit) (to contribute to relieving congestion of local roads).	1
Excluded		4) Other (state content)	1
Total=	**1 Point**		

2.3.4 Waste Treatment Loads

Weighting coefficients(default)= 0.25

Level 2.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	1 point or less in the table of the efforts to be evaluated
■Level 2	2 points in the table of the efforts to be evaluated
Level 3	3 points in the table of the efforts to be evaluated
Level 4	4 points in the table of the efforts to be evaluated
Level 5	5 points or more in the table of the efforts to be evaluated

Efforts to be evaluated

Point	Item	Evaluated Content	Point
0 Point	I. Estimation of types and quantities of waste	1) The types and quantities of waste generated on the site (interior and exterior) on a day-to-day basis have been	1

		estimated to assist in planning measures to reduce the waste processing load.	
1 Point	II. Provision of space and equipment to encourage separate collection	2) Interior and exterior stock space has been planned that will allow sorted collection of many varieties of waste.	1
1 Point		3) Interior and exterior waste sorting and collection containers and boxes has been planned.	1
0 Point		4) Planned collection of valuable materials has been planned (group collections, etc.)	1
0 Point	III. Installation of equipment for waste reduction, compaction or composting	5) Measures are planned to reduce, compact and compost organic garbage (home processing and composting etc. of organic waste).	1
0 Point		6) Reduction and compaction of bottles, cans etc. are planned. 1	1
Total=	**2 Point**		

3 Consideration of Surrounding Environment

3.1 Noise, Vibration & Odor

3.1.1 Noise

		Weighting coefficients(default)= 0.33
Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct	
		If there are no administrative guidelines
Level 1	The current regulation standard 1) set by the Noise Regulation Law is exceeded.	Level 3
Level 2	(No corresponding level)	
■Level 3	Noise is kept below the current regulation standard 1) set by the Noise Regulation Law.	
Level 4	(No corresponding level)	
Level 5	Noise is kept substantially 2) below the current regulation standard 1) set by the Noise Regulation Law.	

*1)Take the current values of the regulation standard, and evaluate facilities accordingly, even if they were installed before the current values came into effect (evaluate for day, morning, evening and night).
*2) For level 5, noise should be limited to below [current standard value -5dB] (for day, morning, evening and night).

Reference 1) Standard Values from the Noise Regulation Law

	a condition of assessment is that the standards must be satisfied for all the measurement times stipulated in the Noise Regulation Law and the Large-Scale Retail Stores Location Law, namely day (8am ~ 7pm), morning and evening (6am ~ 8am, 7pm ~ 10pm) and night (10pm ~ 6am).											
	Type 1 zones			Type 2 zones			Type 3 zones			Type 4 zones		
	Day	Morning & evening	Night	Day	Morning & evening	Night	Day	Morning & evening	Night	Day	Morning & evening	Night
Level 1	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3
Level 2												
Level 3	Not exceeding 45dB	Not exceeding 40dB	Not exceeding 40dB	Not exceeding 50dB	Not exceeding 45dB	Not exceeding 45dB	Not exceeding 60dB	Not exceeding 55dB	Not exceeding 50dB	Not exceeding 70dB	Not exceeding 60dB	Not exceeding 55dB
Level 4												
Level 5	Not exceeding 35dB	Not exceeding 30dB	Not exceeding 30dB	Not exceeding 40dB	Not exceeding 35dB	Not exceeding 35dB	Not exceeding 50dB	Not exceeding 45dB	Not exceeding 40dB	Not exceeding 60dB	Not exceeding 50dB	Not exceeding 45dB

3.1.2 Vibration

Weighting coefficients(default)=	0.33

Excluded	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct	
		If there are no administrative guidelines
Level 1	The current regulation standard 1) set by the Vibration Regulation Law is exceeded.	Exclude
Level 2	(No corresponding level)	
Level 3	Vibration is kept below the current regulation standard 1)set by the Vibration Regulation Law.	
Level 4	(No corresponding level)	
Level 5	Vibration is kept substantially 2) below the current regulation standard 1)set by the Vibration Regulation Law.	

*1)Take the current values of the regulation standard, and evaluate facilities accordingly, even if they were installed before the current values came into effect (evaluate for both day and night).
*2)For level 5, vibration should be limited to below [current standard value -5dB] (for both day and night).

Standard Values from the Vibration Regulation Law

	Type 1 zones		Type 2 zones		—	—
	a condition of assessment is that the standards must be satisfied for all the measurement times stipulated in the Vibration Regulation Law and the Large-Scale Retail Stores Location Law, namely day (8am ~ 7pm), morning and evening (6am ~ 8am, 7pm ~ 10pm) and night (10pm ~ 6am).					
	Day	Night	Day	Night		
Level 1	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3	Not adequate for level 3		
Level 2						
Level 3	Not exceeding 60dB	Not exceeding 55dB	Not exceeding 65dB	Not exceeding 60dB		
Level 4						
Level 5	Not exceeding 55dB	Not exceeding 50dB	Not exceeding 60dB	Not exceeding 55dB		

3.1.3 Odor

Excluded	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct	Weighting coefficients(default)= 0.33 If there are no administrative guidelines
Level 1	Odor level is below the allowable limit for odor index, and for the concentrations of currently designated malodorous substances under the Offensive Odor Control Law.	Exclude
Level 2	(No corresponding level)	
Level 3	Odor level satisfies the allowable limit for odor index, and for the concentrations of currently designated malodorous substances under the Offensive Odor Control Law.	
Level 4	(No corresponding level)	
Level 5	(No corresponding level)	

3.2 Wind Damage & Sunlight Obstruction

3.2.1 Restriction of Wind Damage

Weighting coefficients(default)= 0.70

Level 1.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
■Level 1	No preliminary study or was performed about the creation of strong wind spots and no countermeasures were taken against wind hazard.

Level 2	A preliminary study has been performed and measures taken to avoid or reduce wind hazard, but there has been no assessment. Alternatively, wind strength grade has been evaluated on the basis of a desktop forecast, and wind strength has been worsened in some areas, or there are measurement points at which the wind environment rank for the sight has been lowered.
Level 3	A preliminary study has been performed and measures taken to avoid or reduce wind hazard. Then, the wind strength grade has been evaluated on the basis of a desktop forecast, and the results show that wind strength has not worsened. Alternatively, rank assessment has been performed on the basis of wind environment assessment indices, and the results indicate that a wind environment with suitable rank for the location has been achieved.
Level 4	A preliminary study or prevention planning has been performed and measures taken to avoid or reduce wind hazard, followed by a rank assessment has been performed on the basis of wind environment assessment indices. Results indicate that the wind environment in some parts is better than usual for the location.
Level 5	A preliminary study or prevention planning has been performed and measures taken to avoid or reduce wind hazard, followed by a rank assessment has been performed on the basis of wind environment assessment indices. Results indicate that the wind environment is better than usual for the location.

3.2.2 Restriction of sunlight obstruction

Weighting coefficients(default)=	0.30

Level 4.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	(No corresponding level)
Level 2	(No corresponding level)
Level 3	Shade regulations are satisfied, or there are no shade regulations applicable to the site.
■Level 4	A standard one rank* above the shade regulations is satisfied.
Level 5	(No corresponding level)

* “One rank above” for sunlight obstruction means that, for example, in an area where the shade regulation limits shade on adjacent commercial areas to 5 hours/ 3 hours (at 5m, 10m), the next higher standard is for residential areas, set at 4/ 2.5 hours.
If the strictest level or regulation is already applied, one rank above should be taken to mean one hour/ 0.5 hours (5m, 10m) higher than the regulation standard.

3.3 Light Pollution

3.3.1 Outdoor Illumination and Light that Spills from Interiors

Weighting coefficients(default)=	0.70

Level 5.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	0 points in the table of the efforts to be evaluated
Level 2	1 points in the table of the efforts to be evaluated
Level 3	2 points in the table of the efforts to be evaluated
Level 4	3 points in the table of the efforts to be evaluated
■Level 5	4 points in the table of the efforts to be evaluated

Efforts to be evaluated

Point	Evaluated Content	Point
2 Point	1) Outdoor illumination and light that spills from interiors Only some of the checklist points of the "Light Pollution Countermeasure Guidelines" are satisfied. (1 point) A majority of the checklist points of the "Light Pollution Countermeasure Guidelines" are satisfied. (2 points)	1~2
2 Point	2) Countermeasures against light pollution from billboard lighting. Billboard lighting satisfies some of the considerations in "Considerations for Billboard Illumination." (1 point) A majority of the considerations in "Considerations for Billboard Illumination" are satisfied, or there is no billboard lighting. (2 points)	1~2
Total=	**4 Point**	

3.3.2 Measures for Reflected Solar Glare from Building Walls

Weighting coefficients(default)=	0.3
	0

Level 3.0	Off, Sch, Rtl, Rst, Hal, Hsp, Htl, Apt, Fct
Level 1	Reflected glare from building walls (including glazing) is observed to cause any major impact on the surroundings.
Level 2	(No corresponding level)
■Level 3	Reflected glare from building walls (including glazing) is not observed to cause any major impact on the surroundings.
Level 4	(No corresponding level)
Level 5	Reflected glare from building walls (including glazing) is not observed to cause any reflected glare on the surroundings.

■ LCCO2 Calculation Conditions Sheet (standard calculation)

■Building Name Rinker

CASBEE-NCe_2008(v.2.0)

Item		Reference (Reference Building)	Subject Building	Comments
Building Outline	Building type	Schools,	Schools,	
	Gross Floor Area	4,322m2	4,322m2	
	Structure	S	S	

Lifecycle Setting	Expected Service Life	Schools section, 60years,	Schools section, 60years,	
Construction Stage	CO2 Emission	10.24	10.24	kg-CO2/m2-yr
	Calculation of Embodied CO2	Average in Japan calculated by Architectural Institute of Japan from the 1995 Industrial Input-Output Table	Estimated by subtracting reduced CO2 volume by resource-saving efforts from reference value	
	Reference for CO2 Emission units	Architectural Institute of Japan from the 1995 Industrial Input-Output Table	See reference	
	Boundary	up to the domestic consumption expenditure	See reference	
	Quantities of Representative Materials			
	Regular concrete			m3/m2
	Blast furnace cement concrete			m3/m2
	Steel frame			t /m2
	Steel frame (electric furnace)			t /m2
	Steel reinforcement			t /m2
	Timber			t /m2
	XXX	XXX	XXX	kg/m2
	Environmental Loads of Representative Materials			
	Regular concrete	282.00	282.00	kg-CO2/m3
	Blast furnace cement concrete	206.00	206.00	kg-CO2/m3
	Steel frame	0.90	0.90	kg-CO2/ t
	Steel frame (electric furnace)	0.90	0.90	kg-CO2/ t
	Steel reinforcement	0.70	0.70	kg-CO2/ t
	Formwork	7.20	7.20	kg-CO2/ t
	XXX	XXX	XXX	kg-CO2/kg

	Major Recycled Materials and use rate			
	Blast furnace cement (% in entire main structure)	0%	0%	
	Existing structural members (% in entire main structure)	0%	0%	
	Electric furnace steel（Steel reinforcement）	0%	0%	
	Electric furnace steel（Steel frame）	0%	0%	
Repair, Renewal / Demolition Stage	CO2 Emission	16.68	16.68	kg-CO2/m2-yr
	Renewal intervals (year)			
	Exterior			
	Interior			
	Building Service			
	Average repair rate（%/year）			
	Exterior			
	Interior			
	Building Service			
	Calculation of CO2 emission at demolition stage	Demolition material quantity was assumed to be 2,000kg/m2, and the road transport distance at 30km	See reference	
Operation Stage	CO2 Emission	68.53	26.55	kg-CO2/m2-yr
	Calculation of primary energy consumption	Estimated from the average primary energy consumption in statistical records	Estimate reduction volume of primary energy consumption by the efforts assessed under "LR1 Energy"	
	Primary energy consumption			MJ/year
	CO2 emission coefficient and conversion factor			

	Conversion factor from primary energy consumption		See reference	CO2-kg/MJ
	Electricity	0.555	See reference	CO2-kg/kWh
	Town gas	0.0506	See reference	CO2-kg/MJ
	Other energy source ( )	XXX	See reference	CO2-kg/MJ
	Water			
Other				

Comprehensive Assessment System for Building Environmental Efficiency

CASBEE for New Construction Assessment Software

Microsoft Excel 2003 for Windows XP Edition
CASBEE-NCe_2008v.2.0

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Planning and publication: Institute for Building Environment and Energy Conservation

Inquiries concerning software content, etc. :
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APPENDIX E
GREEN STAR RATING SYSTEM SCORECARD

Please use the tabs at the bottom of the workbook to navigate.

27 July, 2010 *
(Original release 28 August, 2008)

***Please ensure that you are working with the latest release of the Green Star – Education v1 tool.** Green Star rating tools are updated when required, to incorporate improvements made by the Green Star Team. The release date of this tool is shown above. Green Star registered projects are permitted to use the release which was current at the date of registration, or later. Earlier releases must not be used.

Green Star - Education v1

Building Input WorkSheet

New or Refurbished Building:	New Building

Name of Building:	Rinker Hall
Address of Building:	
Postcode:	
State:	NSW

Applicant:	
Contact Person:	

Green Star Accredited Professional:	

Project Manager:	
Architect:	
Structural/Civil Engineer:	
Building Services Engineer:	
Quantity Surveyor:	
Acoustic Consultant:	
Landscaping Consultant:	
Building Surveyor:	
Main Contractor:	
Local Planning Authority:	

Usable Floor Area (UFA) in m2:	4,322
Gross Floor Area (GFA) in m2:	4,322
No. of Storeys:	3
% of Educational Facility Space:	33

Building Description: (Orientation, Form, Structure, Façade, etc.)	North South orientation, steel construction with metal and glazing veneer
Building Services: (Heating, Cooling, Ventilation, Lighting, Lifts, Domestic Hot Water)	heating, cooling, ventilating
Date of Submission:	
Current Project Phase:	
Date of Registration (dd/mm/yy):	1/1/04

Please fill in 'Date of Registration' field above

A number of credits become applicable based on the registration date of the project. Projects registered prior to the release of a revised credit can choose to use the credit in the Technical Manual, or the revised credit. To override the credit selection based on registration date, please click the 'Override Credit Assignments' button, and select the credit that you wish to override.

NB Use of Green Star - Education v1 may predict a rating that differs from that achieved via Green Star certification. Detailed guidance on credit compliance criteria is contained in the Green Star - Education v1 Technical Manual.

Green Star - Education v1

Credit Summary for: Rinker Hall

Management

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed
Man-1	**Green Star Accredited Professional**	To encourage and recognise the engagement of professionals who can assist the project team with the integration of Green Star aims and processes throughout design and construction phases.	Two points are awarded where: • A principal participant in the design team is a Green Star Accredited Professional engaged to provide sustainability advice from the schematic design phase through to construction completion.	2	**2**	
Man-2	**Commissioning - Clauses**	To encourage and recognise commissioning and handover initiatives that ensure that all building services can operate to optimal design potential.	Up to two points are awarded as follows: • One point is awarded where it is demonstrated that: -– Comprehensive pre commissioning, commissioning, and quality monitoring are contractually required to be performed for all building services (BMS, mechanical, electrical and hydraulic); and -– The works outlined above are done in exact accordance with CIBSE Commissioning Codes or ASHRAE Commissioning Guideline 1 1996 (for mechanical services only) and CIBSE Commissioning Codes for the other Services.	1	**1**	

			• An additional point is awarded where it is demonstrated that: – The point above is achieved; and -– The design team and contractor are required to transfer project knowledge to the building owner/manager through all of the following: > documented design intent; > as built drawings; > Operations and Maintenance Manual; > Commissioning Report; and > training of building management staff.	1	**1**	
Man-3	**Building Tuning**	To encourage and recognise commissioning initiatives that ensure optimum occupant comfort and energy efficient services performance throughout the year.	One point is awarded where it is demonstrated that: • After handover, the building owner implements tuning of all building systems; • A relevant member of the design team is involved in the tuning process; • Monthly monitoring is undertaken and the outcomes are reported to the building owner quarterly; • Full re commissioning is undertaken 12 months after practical completion; and • A Building Tuning Report on the outcomes of the tuning process is provided to the building owner and made available to the design team. .	1	**0**	
Man-4	**Independent Commissioning Agent**	To encourage and recognise the appointment of an Independent Commissioning Agent from project design through to handover.	One point is awarded where an Independent Commissioning Agent has been appointed to: • Provide commissioning advice to the building owner and the design team; and • Monitor and verify the commissioning of all building systems.	1	**1**	

Man-5	**Building Guides**	To encourage and recognise information management that enables building users to optimise the building's environmental performance.	Up to two points are awarded as follows: One point is awarded where: • A simple and easy-to-use Building Users' Guide, which includes information relevant for the building users, occupants and tenants' representatives, is developed and made available to the building owner. One point is awarded where: • A Building Maintenance Guide is developed, which provides detailed guidance on accessing and maintaining both the building's services and external building fabric. The guide is to be developed by the design team and made available to the Building Owner/s or Manager.	2	**0**	
Man-6	**Environmental Management**	To encourage and recognise the adoption of a formal environmental management system in line with established guidelines during construction.	Up to two points are awarded independently of each other and as follows: • One point is awarded where it is demonstrated that: --– The contractor implements a comprehensive, project specific Environmental Management Plan (EMP) for the works in accordance with Section 4 of the NSW Environmental Management System guidelines 1998. • One point is awarded where it is demonstrated that: -– The Contractor has valid ISO 14001 Environmental Management System (EMS) accreditation prior to and throughout the project.	2		

Man-7	**Waste Management**	To encourage and recognise management practices that minimise the amount of construction waste going to disposal.	Up to two points are awarded where: • The contractor implements a Waste Management Plan (WMP), retains waste records and submits quarterly reports to the building owner; and • A percentage (by mass) of all demolition and construction waste is re used or recycled as follows: -– One point for 60% of the waste; and --– Two points for 80% of waste.	2	**2**	
Man-8	**Not applicable to this tool**					
Man-9	**Not applicable to this tool**					
Man-10	**Learning Resources**	To encourage and recognise the building and site attributes that serve as an environmental learning resource to all building users.	One point is awarded where: • At least three of the building's environmental attributes are displayed in a manner that can be readily understood by building users, and meet the following criteria: -– Each attribute must reflect an environmental initiative rewarded within a Green Star – Education credit; ---– One attribute must relate to energy use and one attribute must relate to water use; and ---– Each attribute must be clearly displayed and the measurable environmental and economic benefits communicated (e.g. through signage and/or live data) to the casual observer.	1	**1**	

Man-11	**Maintainability**	To encourage and recognise building design that facilitates ongoing maintenance, and minimises the need for ongoing building maintenance throughout a building's lifecycle.	One point is awarded where it is demonstrated that: • The person responsible for maintenance, or a suitably qualified maintenance staff member, or a qualified facilities manager, has performed and submitted a design review at both the preliminary and final design stages. This review must consider the design with respect to access, ongoing maintenance and ongoing cleaning of the following: -– Building services; and ---– External building features.	1	**0**	
			Total Points =	**14**	**8**	**0**

Green Star - Education v1

Credit Summary for: Rinker Hall

Indoor Environment Quality

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed	Comment
		Definition: Usable Floor Area (UFA)	The sum of the floor areas measured at floor level from the general INSIDE face of walls of all spaces related to the Primary Function of the building. This will normally be computed by calculating the Fully Enclosed Covered Area (FECA) and deducting common use areas, service areas, and non-habitable areas. Note: in some cases the Useable Floor Area may include some external covered areas which relate to the Primary Function of the building. Example: an open but roofed hydraulics modelling laboratory associated with Civil Engineering should be counted as part of the UFA. Common use areas include corridors which are defined by partitions but do not include passages and secondary circulation areas which are part of open plan spaces. Foyers of large lecture theatres should be treated as UFA.				

IEQ-1	**Ventilation Rates**	To encourage and recognise designs that provide ample amounts of outside air to counteract build up of indoor pollutants.	Three points are available as follows: **Naturally Ventilated Spaces** Three points are awarded where it is demonstrated that 95% of the nominated area is naturally ventilated in accordance with AS1668.2 2002. **Mechanically Air Conditioned and Mechanically Assisted Naturally Ventilated Spaces** Up to three points are awarded where for 95% of the nominated area, outside air is provided at rates greater than the requirements of AS1668.2 1991, as follows: • One point for 50% improvement; • Two points for 100% improvement; and • Three points for 150% improvement. **Mixed Mode Ventilated Spaces** Both modes of operation must individually satisfy the relevant mechanical and natural ventilation criteria. The points awarded will be limited to the maximum points awarded under the mechanical ventilation criteria. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	3		**3**	

IEQ-2	**Air Change Effectiveness**	To encourage and recognise systems that effectively deliver optimum air quality to any occupant throughout the occupied area.	Two points are awarded where it is demonstrated that the Air Change Effectiveness (ACE) for at least 95% of the nominated area meets the following criteria: **Naturally Ventilated Spaces** • A distribution and laminar flow pattern for at least 95% of the nominated area of each space in the direction of air flow for not less than 95% of standard hours of occupancy is demonstrated. **Mechanically Air Conditioned and Mechanically Assisted Naturally Ventilated Spaces** • The ventilation systems are designed to achieve an Air Change Effectiveness (ACE) of >0.95 for at least 95% of the nominated area when measured in accordance with ASHRAE 129 1997: 'Measuring Air Change Effectiveness'; and • ACE is measured in the breathing zone (nominally one metre above finished floor level). **Mixed Mode Ventilated Spaces** • The ventilation systems are designed to achieve an Air Change Effectiveness (ACE) of >0.95 when measured in accordance with ASHRAE 129 1997: 'Measuring Air Change Effectiveness'; • ACE is measured in the breathing zone (nominally one metre above finished floor level); and • A distribution and laminar flow pattern for at least 95% of the nominated area of each space in the direction of air flow for 95% of hours of predicted natural ventilation operation is demonstrated. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	2		**2**	

IEQ-3	**Carbon Dioxide Monitoring and Control and VOC Monitoring**	To encourage and recognise the provision of response monitoring of Carbon Dioxide and Volatile Organic Compounds (VOC) levels to ensure delivery of optimum quantities of outside air and monitoring of VOC pollutants.	One point is awarded where it is demonstrated that: • A VOC monitoring system is provided that: -– Is linked to the Building Management System; -– Has a minimum of one sensor per return duct; -– Facilitates continuous monitoring of VOC pollutants; and --– Can detect and provide an alarm when VOC pollutants reach 0.5 mg/m3 level. AND **Naturally Ventilated Spaces** • 95% of the nominated area is naturally ventilated in accordance with AS1668.2-2002; and • Ventilation rates are directly controlled by occupants. **Mechanically Air-Conditioned and Mechanically Assisted Naturally Ventilated Spaces** • 95% of the nominated area has a carbon dioxide (CO_2) monitoring and control system with a minimum of one CO_2 sensor at all return points on each floor, is provided to facilitate continuous monitoring and adjustment of outside air ventilation rates to each level, to ensure independent control of ventilation rates to achieve outside air requirements; OR • HVAC systems provide 100% outside air with no recirculated component. **Mixed-Mode Ventilated Spaces** Both modes of operation must satisfy the relevant mechanical and natural ventilation criteria. The points awarded will be limited to the maximum points awarded under the mechanical ventilation criteria. For the purposes of this credit ‘nominated area’ is UFA, excluding external covered areas.	1	**1**		

IEQ-4	**Daylight**	To encourage and recognise designs that provide good levels of daylight for building users.	Up to four points are awarded as follows: • Up to three points are awarded as follows where it is demonstrated that a Daylight Factor (DF) of 2% is achieved at desk-height level (720mm AFFL) under a uniform design sky: - – One point is awarded for 30% of the nominated area; - – Two points are awarded for 60% of the nominated area; and - – Three points are awarded for 90% of the nominated area.	3	**1**	**1**	
			• An additional point is available for primary and secondary schools where: - – A Daylight Factor (DF) of 2% is achieved for 90% of the nominated area; and - – It is demonstrated that 50% of learning spaces achieve a Daylight Factor of not less than 4% for 95% of the area of the learning space, measured at desk height level (720mm AFFL) under a uniform design sky. For tertiary institutions, this additional point is 'Not Applicable' and is excluded from the points available used to calculate the Indoor Environment Quality Category Score – type 'NA' in the 'No. of Points Achieved' column. Learning Spaces include classrooms/multi purpose spaces, computer and physics labs, library, workshops, and gymnasiums. For the purposes of this credit 'nominated area' is UFA (excluding atrium and corridor spaces).	1			

IEQ-5	**Thermal Comfort**	To encourage and recognise buildings that achieve a high level of thermal comfort.	Up to three points are awarded where the following is demonstrated: **Naturally Ventilated and Mechanically Assisted Naturally Ventilated Spaces** Two points are awarded where the Acceptability Limits of ASHRAE Standard 55-2004 are achieved during Standard Operating Hours of Occupancy for 98% of the year: - One point for internal temperatures within 80% of Acceptability Limit 1; and - Two points for internal temperatures within 90% of Acceptability Limit 1. **Mechanically Air-Conditioned Spaces** Two points are awarded where Predicted Mean Vote (PMV) levels, calculated in accordance with ISO7730, are achieved during Standard Operating Hours of Occupancy for 98% of the year using standard clothing and metabolic rate values: - One point for PMV levels between -1 and +1, inclusive; and - Two points for PMV levels are between -0.5 and +0.5, inclusive. **Mixed mode Ventilated Spaces** For mixed mode buildings, the above mechanical and natural ventilation thermal comfort criteria must be met.	2	**2**		

			Naturally Ventilated and Mechanically Assisted Naturally Ventilated Spaces * • One additional point is awarded where either of the first two points are achieved and individual user control of ventilation openings no less than 0.75m2 is provided for every four (or fewer) workstations. **Mechanically Air-Conditioned Spaces** * One additional point is awarded where either one or two points are achieved above and control of air supply rates, air temperature, or radiant temperature is provided for every four (or fewer) workstations. **Mixed mode Ventilated Spaces** For mixed mode buildings, the above mechanical and natural ventilation thermal comfort criteria must be met. **For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.** **The point for individual thermal comfort control need not be assessed for libraries, canteens or gymnasiums (as defined in the Energy Calculator Guide).**	1			
IEQ-6	**Hazardous Materials**	To encourage and recognise actions taken to reduce health risks to occupants from the presence of hazardous materials.	One point is awarded where: • A comprehensive hazardous materials survey has been carried out on the project site, as defined by the relevant Environmental and Occupational Health and Safety (OH&S) legislation; and • Whenever asbestos, lead or polychlorinated biphenyls (PCBs) were found, they have been removed in accordance with the standards listed under Table IEQ-6.1. For new developments or developments in which none of the above hazardous materials were found, this credit is 'Not Applicable' and is	1			

			excluded from the points available used to calculate the Indoor Environment Quality Category Score.				
IEQ-7	**Internal Noise Levels**	To encourage and recognise buildings that are designed to maintain internal noise levels at an appropriate level.	**Building Services Design** • One point is awarded where the building services noise meets the recommended design sound levels provided in Table 1 of AS/NZS2107:2000. **Overall Building** • One point is awarded where it is demonstrated that: - The nominated design sound levels measured in LAeq and reverberation times, for each functional space are provided in accordance with the lower values in Table 1 of AS/NZS2107:2000; and - All partitioning between adjoining academic offices or classrooms is constructed to achieve a weighted sound reduction index (Rw) of at least 45 between spaces. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	2		**2**	

IEQ-8	**Volatile Organic Compound**	To encourage and recognise specification of interior finishes that minimise the contribution and levels of Volatile Organic Compounds in buildings.	Up to four points are awarded where the various finishes and furniture used in the project meet the benchmarks as follows: Paints • One point where at least 95% of all internal painted surfaces meet the Total Volatile Organic Compound (TVOC) Content Limits outlined in Table IEQ 8.1 or where no paint is used in the project.	1	**1**		
			Adhesives and sealants • One point where 95% of all adhesives and sealants meet the TVOC Content Limits outlined in Table IEQ 8.2 or where no adhesives or sealants are used.	1	**1**		
			Carpets and Flooring • One point where all carpets meet the TVOC emissions limits outlined in Table IEQ 8.3 OR • Where no carpet has been installed in the project and projects wish to use low VOC flooring, one point is awarded where all the flooring installed in the project meet the emissions limits outlined in Table IEQ 8.3. Where no carpet has been installed in the project, the carpet point is 'Not Applicable' and is excluded from the points available used to calculate the IEQ Category Score.	1	**1**		
			Tenancy Fitout items • One point where 95% of tenancy fitout items (workstations, walls/partitions, chairs, tables and storage units) meet the TVOC emission limits outlined in Table IEQ 8.4.	1	**1**		

IEQ-9	**Formaldehyde Minimisation**	To encourage and recognise the specification of products with low formaldehyde emission levels.	One point is awarded where all engineered wood products (including exposed and concealed applications) either: • Have low formaldehyde emissions; OR • Contain no formaldehyde. If no engineered wood products are used within the project, this credit is 'Not Applicable' and excluded from the total number of points available to calculate the IEQ Category Score.	1	**1**		
IEQ-10	**Mould Prevention**	To encourage and recognise the design of services that eliminate the risk of mould growth and its associated detrimental impact on occupant health.	One point is awarded where it is demonstrated that: • The mechanically air conditioned ventilation system actively controls humidity to be no more than 60% relative humidity in the space and no more than 80% relative humidity in the supply ductwork; OR • The building is fully naturally ventilated or mechanically assisted naturally ventilated, (MANV).	1	**1**		

IEQ-11	**Daylight Glare Control**	To encourage and recognise buildings that are designed to reduce the discomfort of glare from natural light.	One point is awarded where it is demonstrated that glare from daylight is reduced across the nominated area through any combination of the below: • Where, for each typical glazing configuration or atrium, fixed shading devices shade the working plane, 1.5m in from the centre of the glazing, from direct sun at desk height (720mm AFFL) for 80% of standard occupancy hours; OR • Where blinds or screens are fitted on all glazing and atriums as a base building provision and meet to following criteria; -– Eliminate all direct sun penetration; ---– Are controlled with an automatic monitoring system; --– Are equipped with a manual override function accessible by occupants; and ---– Have a visual light transmittance (VLT) of <10%. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	1	**1**		
IEQ-12	**High Frequency Ballasts**	To encourage and recognise the increase in workplace amenity by avoiding low frequency flicker that may be associated with fluorescent lighting.	• High frequency ballasts are installed in fluorescent luminaires over a minimum of 95% of the nominated area. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	1		**1**	

IEQ-13	**Electric Lighting Levels**	To encourage and recognise lighting that is not over-designed.	One point is awarded where it is demonstrated that: • The facility lighting design provides a maintenance illuminance of no more than 25% above those recommended in Table E1 of AS1680.2.3 for 95% of the nominated area as measured at the working plane (or as required by AS1680.2.3). For the purposes of this credit 'nominated area' is UFA, excluding external covered areas.	1		**1**	
IEQ-14	**External Views**	To encourage and recognise designs that provide occupants with a visual connection to the external environment.	One point is awarded where it is demonstrated that: • 60% of the nominated area has a direct line of sight to the outdoors, or into an adequately sized and day lit internal atrium. For the purposes of this credit 'nominated area' is UFA, excluding external covered areas and gymnasiums.	1	**1**		
			Total Points =	**26**	**12**	**10**	

Green Star - Education v1

Credit Summary for: Rinker Hall

Energy

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed
Ene-	**Conditional Requirement**	To encourage and recognise designs that minimise the greenhouse gas emissions	To meet the conditional requirement: The project's predicted greenhouse gas emissions must meet the greenhouse gas emission benchmark. The Green Star – Education v1 Energy Calculator determines the benchmark for	Conditional Requirement	Yes	

		associated with operational energy consumption, and maximise potential operational energy efficiency of the base building.	each project based on the composition of space types within each project. The conditional requirements are: **Primary and High Schools Conditional Requirements (kgCO2-e/m2/annum)** Classrooms 61 Computer and physics labs 127 Office and staff rooms 85 Library 73 Common space 53 Canteen 65 Workshops 77 Gymnasiums 58 Car parks 58 **Universities Conditional Requirements (kgCO2-e/m2/annum)** Teaching/classroom spaces 82 Dry labs/speciality learning spaces and libraries 88 Office/administrative spaces 79 Common spaces 57 Wet labs (varies based on density of fume cupboards) Gymnasiums 143 Car parks 52				

			The methodology used to establish the conditional requirement for each space type is detailed in the Green Star – Education v1 Energy Calculator Standard Practice Benchmark document available on the GBCA website. The predicted greenhouse gas emissions must be determined using energy modelling in accordance with the final and current version of the Green Star – Education v1 Energy Calculator.			
ne-1	**Greenhouse Gas Emissions**	To encourage and recognise designs that minimise greenhouse gas emissions associated with operational energy consumption.	Up to 20 points are awarded where it is demonstrated that the building's predicted greenhouse gas emissions have been further reduced below the Conditional Requirement. The number of points achieved is determined as follows: Predicted reduction in Greenhouse Gas Points Awarded Emissions (%) 0 Conditional 5 1 10 2 15 3 20	20		

			4 25 5 30 6 35 7 40 8 45 9 50 10 55 11 60 12 65 13 70 14 75 15 80 16 85 17 90 18 95 19 100 – Zero net operating emissions 20		5

Ene-2	**Energy Sub-metering**	To encourage and recognise the installation of energy sub metering to facilitate ongoing management of energy consumption.	• One point is awarded where: - Sub metering is provided to separately monitor lighting and general power consumption for primary functional areas (per floor) as defined in the Technical Manual, these areas include: > class/lecture/tutorial areas; > office/administration space; and > laboratories. Where a functional area is less than 200m2, they may be grouped with an adjacent functional area providing the total area being metered does not exceed 1000m2. The sub meters must be connected to a Building Management System (BMS) or dedicated electronic energy monitoring and reporting system and continually demonstrate actual performance against energy benchmarks.	1		
Ene-3	**Peak Energy Demand Reduction**	To encourage and recognise designs that reduce peak demand on energy supply infrastructure.	Up to two points are awarded where it is demonstrated that the building has reduced its peak energy demand load on electricity infrastructure as follows: • One point where: - Peak energy demand is actively reduced by 15%; OR - A flatter demand curve is achieved, i.e. the difference between the peak and average demand does not exceed 40%; and • Two points where: - Peak energy demand is actively reduced by 30%; OR - A flatter demand curve is achieved, i.e. the difference between the peak and average demand does not exceed 20%.	2		

Ene-4	**Lighting Zoning**	To encourage and recognise lighting design practices that offer greater flexibility for light switching, making it easier to light only occupied areas.	One point is awarded where it is demonstrated that: • An automated lighting control, including occupant detection and daylight adjustment is provided. The nominated area for the purpose of this credit is UFA.	1		
Ene-5	**No applicable to this tool**					
Ene-6	**No applicable to this tool**					
Ene-7	**Unoccupied Areas**	To encourage and recognise designs that minimise or eliminate energy use for spaces when unoccupied.	Up to two points are awarded as follows: • One point is awarded where 60% of the nominated area achieves the below criteria; - – The building is naturally ventilated; OR - – The HVAC system in each separate enclosed space within the nominated area, e.g. laboratory, classroom, office, tutorial space, lecture theatre, is: > designed to be automatically shut down when not in use; OR > designed to allow a wider temperature control band when not in use, a minimum of an additional 2° in each direction is required (e.g. if the band allowed for an occupied room is 20° to 24°C then the band for an unoccupied must be 18° to 26°C). • Two points are awarded where 90% of the nominated area achieves the above criteria. For the purpose of this credit the nominated area is Usable Floor Area (UFA).	2		

Ene-8	**Stairs**	To encourage and recognise buildings that reduce energy consumption by providing accessible and highly visible stairs as an alternative to vertical transportation by lift.	One point is awarded where it is demonstrated that internal stairs meet the following criteria: • Available for use by the building users and, where relevant, the public; • Highly visible (i.e. not visually blocked or behind doors); • Located within 5m of the primary set of lifts OR within 20m of a main entrance; and • At least one of the following: - – 25% of the stairwell wall area is exterior glazing; OR - – Each level within the stairwell has a Daylight Factor of at least 3.5 at finished floor level (FFL); OR - – The stair is fully open to the interior on at least one side over the entire span of the stairwell. If the building is single storey or does not have a passenger or goods passenger lift (dedicated disabled persons lift can be excluded), then the credit is 'Not Applicable' and is excluded from the points available used to calculate the Energy Category Score.	1		
Ene-9	**Efficient External Lighting**	To encourage and recognise designs that facilitates the reduction in energy consumption by external lighting.	One point is awarded where all externally-lit spaces over the entire site meet the following criteria: • All external lighting has a light source efficacy of at least 50 lumens/watt; • 95% of outdoor spaces meet or exceed the minimum requirements of AS1158 for illuminance levels; and • 95% of all external lights are connected to daylight sensors (daylight sensors can be combined with a time switch). Emergency lighting required for BCA compliance is excluded from this credit.	1		

Ene-10	**Shared Energy Systems**	To encourage and recognise the use of shared energy stations that minimise maintenance, energy and resource consumption.	One point is awarded where: • The project is served by an on site energy system shared by at least two buildings. This credit is 'Not Applicable' and is excluded from the points available used to calculate the Energy Category Score if: • The campus contains one building only; or • For refurbishment projects only; no two buildings are within 200m of each other.	1		
			Total Points =	**29**	**5**	**0**

Green Star - Education v1 Energy Calculator

Number of Points Achieved	5

The **Green Star - Education v1 Energy Calculator Guide** provides guidance on each of the required inputs and must be followed to ensure an accurate assessment of the building's energy performance. The benchmark figures used in this energy calculator were calculated based on standard practice greenhouse gas emissions. Details of how the benchmarks were calculated are outlined in the **Green Star - Education v1 Standard Practice Benchmark** document.

Input data in white cells	Calculations Based on Project Data	Calculations Based of Benchmark Data

BUILDING LOCATION AND GREENHOUSE GAS EMISSIONS FACTORS

Facility Type	University Building		
Facility Location		NSW	**Note:** The facility location is selected in the Building Input' tab.

Greenhouse Gas Emissions Factors	Modelled Retail Education Facility Emissions Factor	Benchmark Emissions Factor
Electricity ($kgCO_2$-e/kWh)	1.060	1.120
Gas ($kgCO_2$-e/MJ))	0.066	0.063
Liquid Petroleum Gas (LPG) ($kgCO_2$-e/MJ))	0.065	0.065
Diesel ($kgCO_2$-e/MJ))	0.075	0.075
Coal ($kgCO_2$-e/MJ))	0.093	0.093
Solid Biomas ($kgCO_2$-e/MJ))	0.0018	0.0018
Liquid Biofuels ($kgCO_2$-e/MJ))	0.0003	0.0003

BUILDING SPACE TYPES

Space Types within the building	Space Area (m^2)	HVAC Benchmark Greenhouse Gas Emissions ($kgCO_2$-e/yr)	The Benchmark HVAC Greenhouse Gas Emissions

Teaching / Classroom Spaces	1,440	57,092	by Space Type are calculated by multiplying the space area by a per metre squared benchmark
Dry Labs / Specialty Learning Spaces / Libraries	111	5,160	
Office / Administrative Spaces	1,440	38,681	
Common Spaces	1,331	26,154	
Wet Labs	0	0	
Gymnasiums	0	0	
		0	
		0	

Car Park	0		0
Subtotal	**4,322**		**127,087**

Total peak air exhaust rate in wet lab areas (l/s)	0
Number of car parking spaces	8

MODELLING INFORMATION

Modelled Facility Energy Consumption		**Modelled Energy Consumption (kWh/yr Electricity, MJ/yr Gas)**	**Modelled Greenhouse Gas Emissions (kgCO2-e/yr)**	**Benchmark HVAC Greenhouse Gas Emissions ($kgCO_2$-e/yr)**	
HVAC Energy Consumption (incl. boilers, chillers, and fans)	**Total Electricity (kWh/yr)**	78000	**82,680**	127,087	**The Total Benchmark HVAC Greenhouse**

	Gas (MJ/yr)	13064	**864**	**Gas Emissions are calculated by adding the emissions by space type in the table above**
Co-generation and Tri-generation	Select Fuel Type		**0**	
Subtotal			**83,544**	

Lighting Energy Consumption	**Modelled Energy Consumption (kWh/yr)**	**Modelled Greenhouse Gas Emissions ($kgCO_2$-e/yr)**	**Benchmark Greenhouse Gas Emissions ($kgCO_2$-e/yr)**
Teaching / Classroom Spaces	28,178	29,869	41,933
Dry Labs / Specialty Learning Spaces / Libraries	2,172	2,302	3,232
Office / Administrative Spaces	38,558	40,871	57,378
Common Spaces	15,026	15,928	22,361

Wet Labs		0	0
Gymnasiums		0	0
Car Parks	0	0	0
Subtotal	**83,934**	**88,970**	**124,904**

Extras	**Modelled Energy Consumption (kWh/yr)**	**Modelled Greenhouse Gas Emissions ($kgCO_2$-e/yr)**	**Benchmark Greenhouse Gas Emissions ($kgCO_2$-e/yr)**
Gymnasium Mechanical Exhaust		0	0

Car Park Mechanical Exhaust			0	0
Lifts		26,000	27,560	27,592
Escalators and Travelators			0	0
Domestic Hot Water	**Electricity (kWh/yr)**	11,000	11,660	11,908
	Gas (MJ/yr)		0	0
Other			0	0
Subtotal		**37,000**	**39,220**	**39,500**

On-site Electricity Generation	**Electricity Generation (kWh/yr)**	**Greenhouse Gas Emissions Avoided ($kgCO_2$-e/yr)**

Total renewable Energy Generation (kWh/yr) (e.g. Photovoltaics, geothermal and wind, but not solar hot water)		0
Total Electricty produced by Co-generation and Tri-generation (kWh/yr)		0

RESULTS SUMMARY

	Total Project Energy Consumption (kWh/yr Electricity, MJ/yr Gas)	Total Project Greenhouse Gas Emissions ($kgCO_2$-e/yr)	Total Benchmark Greenhouse Gas Emissions ($kgCO_2$-e/yr)
Grid electricity	**198,934**	**210,870**	289,950
Gas	**13,064**	**864**	1,541
Liquid Petroleum Gas	**0**	**0**	/
Diesel	**0**	**0**	/
Coal	**0**	**0**	/
Solid Biomass	**0**	**0**	/
Liquid Biofuels	**0**	**0**	/
TOTAL		**211,734**	**291,491**

Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	**79,757**
Percentage reduction of Greenhouse Gas Emissions compared to the Standard Practice Benchmark	**27.4%**

POINT SCORE CALCULATION

Green Star Points	Percentage reduction of Greenhouse Gas Emissions compared to the Standard Practice Benchmark	Maximum greenhouse gas emissions to achieve points ($kgCO_2$-e/yr)
20	100%	**0**
19	95%	**14575**
18	90%	**29149**
17	85%	**43724**
16	80%	**58298**
15	75%	**72873**
14	70%	**87447**
13	65%	**102022**
12	60%	**116596**
11	55%	**131171**
10	50%	**145745**

9	45%	160320
8	40%	174895
7	35%	189469
6	30%	204044
5	25%	218618
4	20%	233193
3	15%	247767
2	10%	262342
1	5%	276916
Conditional Requirement	0%	291491

Is the Conditional Requirement met?	Yes
Number of Points Achieved	5

The project's emissions must be less than or equal to the benchmark to meet the conditional requirement.

End

Green Star - Education v1

Credit Summary for: Rinker Hall

Transport

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed
Tra-1	**Provision of Car Parking**	To encourage and recognise developments that limit the facilities provided for cars.	Up to two points are awarded as follows: • One point is awarded where the number of car parking spaces is: – At least 25% less than the maximum local planning allowances applicable to the project. OR – Not exceeding the minimum planning allowance by more than 10%. • Two points are awarded where the number of car parking spaces is: – At least 50% less than the maximum local planning allowances applicable to the project. OR – No more than the minimum local planning allowances. Where car parking is not permitted in the local planning scheme, this credit is 'Not Applicable' and is excluded from the points available to calculate the Transport Category Score.	2	**0**	**2**

Tra-2	**Fuel Efficient Transport**	To encourage and recognise developments that facilitate the use of fuel efficient vehicles.	If no parking spaces are to be provided, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Transport Category Score. One point is awarded where: • A minimum of 25% of the total parking spaces on the site are designed and labelled for small cars in accordance with AS/NZS 2890.1:2004 (i.e. maximum 2.3m wide x 5.0m long) and/or mopeds/motorbikes. The greatest of 10 parking spaces or 10% of the total parking spaces must be for small cars (rather than mopeds/motorbikes); and • A minimum of 10% of the total preferred parking spaces (i.e. located near the facility entrance) are dedicated solely for use by car pool participants, hybrid or other alternative fuel vehicles and be clearly signposted and marked with a separate colour from other parking spaces.	1		

Tra-3	**Cyclist Facilities**	To encourage and recognise building design that promotes the use of bicycles by ensuring adequate cyclist facilities are provided.	Up to four points are awarded as follows: **Students** For primary and secondary schools: • One point is awarded where a minimum of one secure bicycle storage space per five students (over grade 4) are provided; and • Two points are awarded where a minimum of two secure bicycle storage spaces per five students (over grade 4) are provided. For universities and colleges: • One point is awarded where a minimum of 5% of the peak number of students using the building at any one time (with 75% occupancy) are provided with a secure bicycle storage space. • Two points are awarded where a minimum of 10% of the peak number of students using the building at any one time (with 75% occupancy) are provided with a secure bicycle storage space. **Staff** • One point is awarded where cyclist facilities are provided for 5% of building staff; and • Two points are awarded where cyclist facilities are provided for 10% of building staff.	4	**2**	

Tra-4	**Commuting Mass Transport**	To encourage and recognise developments that facilitate the use of mass transport.	Up to five points are awarded for the quality of mass transport options available to building users. The points are determined using the Green Star Mass Transport Calculator based on: • The type of mass transport services available within 1000m of the site; • The number of routes served; and • The average interval between services during weekday peak hours. OR For primary or secondary schools: • Four points are awarded where: – Transport is provided for 80% of the students; and – This service is provided to school every morning and from school every afternoon.	5	**4**	
Tra-5	**Not applicable to this tool**					
Tra-6	**Transport Design and Planning**	To encourage and recognise site design and planning that promote transport modes of low environmental impact.	One point is awarded where it is demonstrated that: • At least one dedicated pedestrian route is provided on and off the site; and • A Travel Plan has been developed, that includes: – A site specific transport assessment; and – A report on sustainable transport initiatives.	1	**0**	
			Total Points =	**13**	**6**	**2**

Green Star - Education v1

Credit Summary for: Rinker Hall

Water

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed	Comments
Wat-1	**Occupant Amenity Water**	To encourage and recognise designs that reduce potable water consumption by building occupants.	Up to five points are awarded where: • The predicted potable water consumption for sanitary use within the building has been reduced against a 'best practice' benchmark. The points are determined by the Green Star Potable Water Calculator.	5	**4**		
Wat-2	**Water Meters**	To encourage and recognise the design of systems that both monitor and manage water consumption.	One point is awarded where: • Water meters are installed for all major water uses in the project; and • There is an effective mechanism for monitoring water consumption data.	1	**0**		

Wat-3	**Landscape Irrigation**	To encourage and recognise the design of systems that aim to reduce the consumption of potable water for landscape irrigation.	Three points are awarded where: • Potable water consumption for landscape irrigation has been reduced by 90% OR • A xeriscape garden has been installed. If there is no landscaping, or landscaping represents less than 1% of the site area, this point is 'Not Applicable' and is excluded from the points available used to calculate the Water Category Score.	3	**3**		
Wat-4	**Heat Rejection Water**	To encourage and recognise design that reduces potable water consumption from heat rejection systems.	Up to four points are awarded as follows: • Two points are awarded where: – Potable water consumption of water based heat rejection systems is reduced by 50%. • Four points are awarded where: – Potable water consumption of water based heat rejection systems is reduced by 90%; OR – No water based heat rejection systems are provided.	4	**4**		

Wat-5	**Fire System Water**	To encourage and recognise building design which reduces consumption of potable water for the building's fire protection and essential water storage systems.	One point is awarded where: • There is sufficient temporary storage for a minimum of 80% of the routine fire protection system test water and maintenance drain downs, for re-use on site; and • Each floor fitted with a sprinkler system has isolation valves or shut off points for floor by floor testing; OR One point is awarded where: • The fire protection system does not expel water for testing. If the building does not have a sprinkler system, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Water Category Score.	1	**0**		
Wat-6	**Potable Water Use in Laboratories**	To encourage and recognise designs that reduce demand on potable water consumption from laboratory equipment cooling.	Two points are awarded where it is demonstrated that: • 95% of the water requirement for once through cooling is sourced from non potable water; OR • There is no once through cooling for any equipment (excluding water for cooling tower makeup or other evaporative systems). If less than 10% of the nominated area is devoted to laboratories, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Water Category Score. For the purposes of this credit 'nominated area' is UFA.	2		**2**	
			Total Points =	**16**	**11**	**2**	

Green Star - Education v1 Potable Water Calculator

Points Achieved	4

Facility Type	University Building

AREAS BY SPACE TYPE:

Space Type	Area (m²)
Teaching / Classroom Spaces	1440
Dry Labs / Specialty Learning Spaces	111
Office/Administrative Space	1440
Common spaces	1331
Wet Labs	
Gymnasiums	

TOTAL (m²)	4,322

WATER CONSUMPTION DUE TO FITTINGS:

Toilets	Water Efficiency (Enter manually OR nominate WELS star rating)		L/flush	Percentage of type
	Manual entry from Manufacturer's data sheet (L/flush)	WELS Star rating selection		
Toilets	6		6	100%
<enter description here>			0	
<enter description here>			0	
<enter description here>			0	

Urinals	Water Efficiency (Enter manually OR nominate WELS star rating)		L/flush	Percentage of type
	Manual entry from Manufacturer's data sheet (L/flush)	WELS Star rating selection		
standard	3.8		3.8	50%
waterless	0		0	50%
<enter description here>			0	

<enter description here>			0	
Urinal flushes on auto timer			0	
Enter number of urinals on autotimer				

	Water Efficiency (Enter manually OR nominate WELS star rating)		L/min	Percentage of type
Indoor Taps	**Manual entry from Manufacturer's data sheet (L/min)**	**WELS Star rating selection**		
lavatory	9.5		9.5	100%
<enter description here>			0	
<enter description here>			0	
<enter description here>			0	

Shower Demand:	No showers installed (except in gymnasium)

	Water Efficiency (Enter manually OR nominate WELS star rating)		L/min	Percentage of type
Showerheads	**Manual entry from Manufacturer's data sheet (L/min)**	**WELS Star rating selection**		
<enter description here>			0	

<enter description here>			0	
<enter description here>			0	
<enter description here>			0	

Please ensure percentages add up to 100%

Total Water Consumption (L/day/m^2)	**0.47**

POTABLE WATER REDUCTION DUE TORAINWATER, GREYWATER OR BLACKWATER:

Are there any rainwater or recycled water systems (greywater, blackwater or other) installed?	**Yes**
Do you wish to use the Simple Calculators (below) to calculate rainwater and greywater water availability?	**Yes**

Rainwater	0%	0%
Greywater and/or Blackwater		
Enter amount of rainwater available (L/day)	0	
Enter amount of greywater and blackwater available (L/day)		
Enter the amount of Rainwater used for other purposes than toilets and urinals (e.g. irrigation, cooling towers, car washing) (L/day)		
Enter the amount of Greywater and/or Blackwater used for other purposes than toilets and urinals (e.g. irrigation, cooling towers, car washing) (L/day)		

SIMPLE RAINWATER CALCULATOR:

Enter the average annual rainfall (mm)	1016
Enter the roof area for rainwater collection (m^2)	1440

Select run-off coefficient	Flat non-absorbent roof (<30 pitch)	**0.8**	
Enter the rainwater tank size (kL)		**44853**	
		Toilets	**Urinals**
Enter the percentage of toilets and urinals that are flushed using rainwater		**100%**	**50%**
Enter the amount of rainwater used for purposes other than toilet and urinal flushing (e.g. irrigation, cooling towers, car washing) in litres per day		**0**	

SIMPLE GREYWATER CALCULATOR

	Toilets	**Urinals**

Enter the percentage of toilets and urinals to be flushed using greywater		
	Showers	**Taps**
Enter the percentage of taps and showers used for greywater collection		

The following estimated total potable water consumption is based on the data entered above. The water consumption of the fittings per person is based on assumptions of typical education facility usage. The benchmarks for the credits are shown below and are based on the Water Conservation Rating & Labelling Scheme and assumed usage (including expected use of showers).

Estimated Total Potable Water Consumption (L/day/m²)	**0.14**

Points Achieved	**4**

Points Available	

Water Consumption (Potable Water Litres/day/m²)	Points
0.38	1
0.31	2
0.25	3
0.18	4
0.11	5

Green Star - Education v1

Credit Summary for: Rinker Hall

Materials

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed
Mat-1	**Recycling Waste Storage**	To encourage and recognise the inclusion of storage space that facilitates the recycling of resources used within buildings to reduce waste going to landfill.	Two points are awarded where a dedicated storage area for the separation and collection of recyclable waste is provided and it: • Is adequately sized to handle the recyclable waste streams specified in the Compliance Requirements; • Meets the access requirements of 'Policy for Waste Minimisation in New Developments' (NSW, 2004): – Section A, points A 12 through A 17. • Is separate from, but adjacent to, general waste facilities; • Is located in the same level as the loading dock with a clearly marked, sign posted, convenient and guaranteed access route which allows: – Level access from tenancies (or goods lifts are provided); and – Avoids the need for manual handling of the waste; OR Is within one of the following walking distances: – 20m of the exit used for recycling pick up; – 20m of the lift core serving all floors; or – 3m of the shortest route connecting the lift core serving all floors and the exit used for recycling pick up.	2	**1**	

Mat-2	**Building Reuse**	To encourage and recognise developments that re-use existing buildings to minimise materials consumption.	• Two points are awarded where it is demonstrated that at least 50% of the total façade of the building by area comprises re-used building facade. • Up to four points are awarded where a proportion of the existing major structure, by gross building volume, is re-used: – Two points for 30% re-use; – Three points for 60% re-use; – Four points for 90% re-use. Where the site contained no buildings at the time of purchase, or the total GFA of the original building(s) is less than 20% of the nominated area of the new building that replaces it, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Materials Category Score. The nominated area for the purpose of this credit is GFA.	0	**na**	
Mat-3	**Recycled Content & Re-used Products and Materials**	To encourage and recognise designs that prolong the useful life of existing products and materials and encourage uptake of products with recycling content.	One point is awarded where at least 2% of the project's total contract value is represented by: • Re used products/materials; OR • Has a post consumer recycled content of at least 20%. This credit excludes materials specifically addressed by other credits (i.e. steel, concrete, PVC and timber); neither does it address the re use of the original building(s) on the site (addressed in Mat 2 'Building Re use').	1	**1**	

Mat-4	**Concrete**	To encourage and recognise the reduction of embodied energy and resource depletion occurring through use of concrete.	Three points are available as follows: • Up to two points are available where the project has reduced the absolute quantity of Portland cement, as an average across all concrete mixes, by substituting it with industrial waste product(s) or oversized aggregate as follows: – For one point, 30% for in situ concrete, 20% for pre cast concrete and 15% for stressed concrete; – For two points, 60% for in situ concrete, 40% for pre cast concrete and 30% for stressed concrete. • An additional point is awarded where: – At least one of the above points is achieved; – 20% of all aggregate used for structural purposes is recycled (Class 1 RCA in accordance with HB155 2002) or slag aggregate; and – No natural aggregates are used in non structural uses (e.g. building base course, sub grade to any car parks and footpaths, backfilling to service trenches, kerb and gutter). If the material cost of new concrete represents less than 1% of the project's contract value, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Materials Category Score.	3		**1**
Mat-5	**Steel**	To encourage and recognise the reduction in embodied energy and resource depletion associated with reduced use of virgin steel.	Up to two points are awarded as follows: • One point is awarded where: – 60% of all steel, by mass, in the project either has a post consumer recycled content greater than 50%, or is re-used. • Two points are awarded where: – 90% of all steel, by mass, in the project either has a post consumer recycled content greater than 50%, or is re-used. If the material cost of steel represents less than 1% of the project's total contract value, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Materials Category Score.	2	**2**	

Mat-6	**PVC Minimisation**	To encourage and recognise the reduction in use of polyvinyl chloride (PVC) products in buildings.	Up to two points are awarded as follows:• One point is awarded where: – 30% of the total cost of PVC content was reduced through replacement with alternative materials.• Two points are awarded where: – 60% of the total cost of PVC content was reduced through replacement with alternative materials.Please refer to the Technical Clarifications page on the GBCA website at www.gbcaus.org for updates and further information.	2	**0**	
Mat-7	**Sustainable Timber**	To encourage and recognise the specification of re-used timber products or timber that has certified environmentally responsible forest management practices.	Two points are awarded where: • 95% (by cost) of all timber products used in the building and construction works have been sourced from any combination of the following: – Re-used timber; – Post consumer recycled timber; or – Forest Stewardship Council (FSC) Certified Timber. If the material cost of timber represents less than 0.1% of the project's total contract value then this credit is 'Not Applicable' and is excluded from the points available used to calculate the Materials Category Score. Please refer to the Technical Clarifications page on the GBCA website at www.gbca.org.au for updates and further information.	2	**2**	
Mat-8	**Design for Disassembly**	To encourage and recognise designs that minimise the embodied energy and resources associated with demolition.	One point is awarded where: • 50% (by area) of the structural framing, roofing, and façade cladding systems are designed for disassembly; OR • 95% of the total façade is designed for disassembly. If the material cost of the structural framing, roofing, and facade cladding systems represent less than 1% of the project's total contract value, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Materials Category Score.	1	**1**	

Mat-9	**Dematerialisation**	To encourage and recognise designs that require less material than conventional designs.	One point is available where a substantial reduction in materials consumption occurs as follows: • Where within projects where at least 50% of the nominated area is framed in structural steel, and where it is demonstrated that the building's structural requirements and integrity have been achieved using 20% less steel (by mass) than in a structure with conventional steel framing, without changing the load path to other structural components; OR • Where any two of the initiatives below are demonstrated: Structure - Within projects where at least 50% of the nominated area is framed in structural steel, and where it is demonstrated that the building's structural requirements and integrity have been achieved using 10% less steel (by mass) than in a structure with conventional steel framing, without changing the load path to other structural components; Ductwork - The building is fully naturally ventilated; OR - The requirement for ductwork has been reduced by 95%.	1		**1**

			Finishes As installed final design must require no finish: - 95% of all base building floor material is exposed structure with no covering (e.g. exposed sealed concrete floor); OR - 95% of all base building ceiling is exposed structure (and services, where relevant) with no cladding (e.g. exposed concrete ceiling). Cladding - 25% of the roof cladding area has a dual function (e.g. roof garden substrate or photovoltaic shingles serve as cladding); OR - 25% of the façade cladding area has a dual function (e.g. photovoltaic panels serve as cladding). Piping - No piping is used for urinals (i.e. all urinals are waterfree); OR - No piping is used for toilets (i.e. all toilets are waterfree); OR - Mass of underground piping is reduced by 25% for the same functional requirement and material.			
Mat-10	**Not appliable to this tool**					

Mat-11	**Flooring**	To encourage and recognise the selection of flooring that has a reduced environmental impact relative to available alternatives.	Up to three points are awarded where it is demonstrated that:• The flooring used in the project has a reduced environmental impact as determined by the Flooring Calculator under the following assessment categories: – **Environmentally Innovative:** flooring that has been certified for its environmental merit by a third party recognised by the Green Building Council of Australia; – **Re-use:** flooring that is i) brought from the tenant's previous premises ii) pre existing in the building from a previous tenant or iii) purchased from a second hand retailer; – **Eco Preferred Content:** content certified for its environmental merit by a third party recognised by the Green Building Council of Australia, (score determined by percentage mass); – **Durability:** the length of the warranty of the flooring is assessed; – **Environmental Management System (EMS):** a manufacturers' environmental management system is required; if the system is ISO14001 certified, extra points are awarded;	3	**0**		

			– **Product Stewardship:** a contractual agreement to ta the end of its service life for re use, recycling or re proce – **Modularity:** flooring that has been manufactured wit dimensions or design that enable the item to be arrange together in various configurations; and – **Design for Disassembly:** flooring that can be readil non specialist tools, into elemental components for re us processing. An item is considered to be designed for dis 50% of the item (by mass) can be readily disassembled, are awarded where the percentage exceeds 90%. Maximum points can only be awarded if information reg tenancy project is provided.				

Mat-12	**Joinery**	To encourage and recognise the selection of joinery that has a reduced impact on the environment relative to available alternatives.	One point is awarded where it is demonstrated that: • The joinery used has a reduced environmental impact as determined by the Mat 12 Joinery Calculator under the following assessment categories: – **Environmentally Innovative:** joinery that has been certified for its environmental merit by a third party recognised by the Green Building Council of Australia; – **Re-use:** joinery that is i) brought from the tenant's previous premises ii) pre existing in the building from a previous tenant or iii) purchased from a second-hand retailer; – **Eco Preferred Content:** content certified for its environmental merit by a third party recognised by the Green Building Council of Australia, (score determined by percentage mass); – **Modularity:** joinery that has been manufactured with standardised dimensions or design that enable the item to be arranged, fitted or stacked together in various configurations; and – **Design for Disassembly**: joinery that can be readily non specialist tools, into elemental components for re us processing. An item is considered to be designed for dis 50% of the item (by mass) can be readily disassembled. Where percentage exceeds 90%, this is more highly rewarded i calculator.	1	0	

Mat-13	**Loose Furniture**	To encourage and recognise the selection of loose furniture that has a reduced environmental impact relative to available alternatives.	Up to three points are awarded where it is demonstrated that: • The loose furniture (defined as chairs, tables and storage only) used in the project has a reduced environmental impact as determined by the Loose Furniture Calculator under the following assessment categories: – **Environmentally Innovative:** loose furniture that has been certified for its environmental merit by a third party recognised by the Green Building Council of Australia; – **Re-use:** loose furniture that is i) brought from the tenant's previous premises ii) pre existing in the building from a previous tenant or iii) purchased from a second-hand retailer; – **Eco Preferred Content:** content certified for its environmental merit by a third party recognised by the Green Building Council of Australia, (score determined by percentage mass); – **Durability:** the length of the warranty of the furniture is assessed; – **Environmental Management System:** A Manufacturer's environmental management system is required; if the system is ISO 14001 certified extra points are awarded;	3	**0**	

			– Product Stewardship: A contractual agreement to ta the end of its service life for re use, recycling or re proce **– Design for Disassembly:** loose furniture that can be using non specialist tools, into elemental components fo processing. An item is considered to be designed for dis 50% of the item (by mass) can be readily disassembled, are awarded where the percentage exceeds 90%.			
			Total Points =	**21**	**7**	**2**

Green Star - Education v1

Credit Summary for: **Rinker Hall**

Land Use & Ecology

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed	Comments

Eco -	**Conditional Requirement**	To encourage and recognise development on land that has limited ecological value and to discourage development on ecologically valuable sites.	The Eco-Conditional Requirement is met where the project site is not: • On prime agricultural land; should the project site be on prime agricultural land then this project is not eligible for a Green Star certified rating; • On land containing old-growth forest; should the project site be on land containing old-growth forest then this project is not eligible for a Green Star certified rating; • Within 100 metres of a wetland listed as being of 'high ecological value'. Should the project site be within 100 metres of a wetland listed as being of 'high ecological value', then the project can only be deemed eligible for a Green Star certified rating if the project is defined as a 'refurbishment' and the Wetland Protection Measures (outlined below) have been completed; • Within 100 metres of a wetland NOT listed as being of high ecological value. Should the project site be within 100 metres of a wetland NOT listed as being of high ecological value, then the project can only be deemed eligible for a Green Star certified rating if the	Conditional Requirement	**Yes**		

			Wetland Protection Measures (outlined below) have been completed. Wetland Protection Measures • A site-specific Wetland Management Plan has been produced, exhibited and implemented; and • All points are achieved in Emi-5 'Watercourse Pollution' and in Emi-7 'Light Pollution'. The GBCA reserves the right to provide the final ruling on a project's compliance with this Conditional Requirement.				
Eco-1	**Topsoil**	To encourage and recognise construction practices that conserve the ecological integrity of topsoil.	One point is awarded where: • All topsoil impacted by the construction works is separated and protected from degradation, erosion or mixing with fill or waste; • There is no net change in the volume of topsoil on the site; and • 95% of all topsoil (by volume) retains its productivity. This credit is 'Not Applicable'	1	**0**		

			and is excluded from the points available used to calculate the Land Use and Ecology Category Score where: • No topsoil was impacted by the construction works; • The project is a refurbishment; or • The topsoil on site is inherently non productive.				
Eco-2	**Reuse of Land**	To encourage and recognise the re-use of land that has previously been developed.	One point is awarded as follows: • If the project is a refurbishment; OR • A building extension, where the extension boundaries are within a site that has been previously built on; OR • If at the time of the site purchase, 75% of the site has been previously built on.	1	**1**		
Eco-3	**Reclaimed Contaminated Land**	To encourage and recognise developments that reclaim contaminated land that otherwise would not have been developed.	Two points are awarded where: • The site was contaminated at the time of purchase; and • The developer has undertaken full remedial steps to decontaminate the site prior to construction. This credit is ‘Not Applicable’ for projects that are refurbishments or building extensions, and is excluded from the points available used to calculate the Land	2	**0**		

			Use and Ecology Category Score.				
Eco-4	**Ecological Value of Site**	To encourage and recognise developments that maintain or enhance the ecological value of their sites.	Up to four points are awarded v • For Greenfield sites, the site h vulnerable species and for re-u refurbishments), such species a • There is no net reduction of na • The ecological value of the sit is enhanced beyond its previou The points are determined by th Ecology Calculator on the basis 'before' and 'after' ecological va	4	1		
			Total Points =	**8**	**2**	**0**	

Green Star - Education v1

Credit Summary for: **Rinker Hall**

Emissions

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed	Comments
Emi-1	**Refrigerant ODP**	To encourage and recognise the selection of refrigerants that do not contribute to long term damage to the Earth's stratospheric ozone layer.	One point is awarded where: • All HVAC refrigerants have an Ozone Depleting Potential (ODP) of zero; OR • No refrigerants are used.	1	**0**		
Emi-2	**Refrigerant GWP**	To encourage and recognise the selection of refrigerants that reduce the potential for increased global warming from the emission of refrigerants to the atmosphere.	Up to two points are awarded as follows: • One point where 50% of the fluorocarbon refrigerant charge has been replaced with refrigerant(s) that have a Global Warming Potential (GWP100) of 10 or less; • Two points where: – All refrigerants have a GWP100 of 10 or less; OR – Where no refrigerants are used at all.	2	**0**		

Emi-3	**Refrigerant Leaks**	To encourage and recognise building systems design that minimises environmental damage from refrigerant leaks.	Up to two points are awarded as follows: • One point is awarded where: – HVAC Systems containing refrigerants are contained in a moderately airtight enclosure; and – A refrigerant leak detection system is installed to cover high risk parts of the plant. • An additional point is awarded where: – The point above is achieved; and – The project has installed a refrigerant recovery system that is: > equipped with an automated pump down system; and > sized to effectively and safely capture, isolate, and store 95% (by weight) of the maximum refrigerant charge. Where the project is fully naturally ventilated or is fully mechanically assisted naturally ventilated OR if all points in Emi 1 'Refrigerant ODP' and Emi 2 'Refrigerant GWP' are achieved, this credit is 'Not Applicable' and is excluded from the points available used to calculate the Emissions Category Score.	2	**0**		
Emi-4	**Insulant ODP**	To encourage and recognise the selection of insulants that do not contribute to long term damage to the Earth's stratospheric ozone layer.	One point is awarded where all thermal insulants in the project avoid the use of ozone depleting substances in both its manufacture and composition.	1	**0**		

Emi-5	**Watercourse Pollution**	To encourage and recognise developments that minimise stormwater run off to, and the pollution of, the natural watercourses.	Up to three points are awarded as follows: • Two points are awarded where: – The development does not increase peak stormwater flows for rainfall events of up to a 1 in-2 year storm; and – All stormwater leaving the site, at any time up to a 1 in 20 year storm event, is treated or filtered in accordance with either: > Urban Stormwater Best Practice Environmental Management Guidelines (CSIRO 1999) OR > Australian and New Zealand Environment Conservation Council (ANZECC)'s Guidelines for Urban Stormwater Management.	2	**2**		
			• An additional point is awarded where: – The points above are achieved; and – A Riparian Buffer Zone (RBZ) that has three separate zones of pollution buffering is installed within nine metres of a waterway or natural watercourse and the development. Where the project site does not contain or is not immediately adjacent to a waterway, the additional point is 'Not Applicable' and is excluded from the points available used to calculate the Emissions Category Score.	1	**0**		

Emi-6	**Discharge to Sewer**	To encourage and recognise developments that minimise discharge to the municipal sewerage system.	Up to three points are available as follows: • Up to two points are awarded where the building outflows to the sewerage system due to building occupants' usage have been reduced against an average practice benchmark as follows: – One point for a 20% reduction; and – Two points for a 40% reduction.	2	**0**		
			• An additional point is awarded where: – At least one point above was achieved; and – There is a Blackwater Treatment Maintenance Plan; and – There is a maintenance contract for a minimum of five years to ensure that the blackwater treatment system operates as intended by the design. Where no blackwater treatment system is installed, the additional point is 'Not Applicable' and is excluded from the points available used to calculate the Emissions Category Score.	1			
Emi-7	**Light Pollution**	To encourage and recognise developments that minimise light pollution into the night sky.	One point is awarded where: • No direct light beam, generated from within the building or outside of the building boundary, is directed at any point in the sky; • The path of any direct light's angle of incidence directed to the sky must be obstructed by a non transparent surface; • The lighting design complies with AS4282 'Control of the Obtrusive Effects of Outdoor Lighting'; and • 95% of outdoor spaces do not exceed the minimum requirements of AS1158 for illuminance levels.	1	**1**		

Emi-8	Legionella	To encourage and recognise building systems designed to eliminate the risk of Legionnaire's disease (Legionellosis) as far as is reasonably practicable.	• There are no water based heat rejection system(s) serving the building; OR • Water-based heat rejection system(s) meet all of the following: - -Do not contain water that is kept at a temperature between 20ºC and 50ºC; - -Do not release an aerosol spray during operation; - -Are designed and built to maintain constant movement of the water in the system, when in operation, to prevent stagnation; - -Are designed and built for routine and periodic flushing to remove bio-film buildup and stagnant water from the system(s) whenever it is not in operation; and - -Are designed, located and built in accordance with AS/NZS 3666.1:2002; AND • A Legionella Risk Management plan has been prepared in accordance with AS/NZS 3666.2:2002 or AS/NZS 3666.3:2000 and has been included in the O&M manual provided to the building owner. This credit is applicable to all projects registered after December 18th, 2008. All projects registered prior to this date can choose to use this new credit in its entirety or use the credit issued within the Technical Manual.	1	**1**		
			Total Points =	**14**	**4**	**0**	

Green Star - Education v1

Credit Summary for: Rinker Hall

Innovation

Ref No.	Title	Aim of Credit	Credit Criteria Summary	No. of Points Available	No. of Points Achieved	Points to be Confirmed	Comments
Inn-1	**Innovative Strategies & Technologies**	To encourage and recognise pioneering initiatives in sustainable design, process or advocacy.	Up to two points can be awarded for an innovation initiative where: • The initiative is a technology or process that is considered a ‘first’ in Australia or in the world; or • The project substantially contributes to the broader market transformation towards sustainable development in Australia or in the world. Points for this credit are allocated as follows: • One point is awarded when either of the above is true for the Australian market; and • Two points are awarded when either of the above is true for the global market. No individual initiative can achieve more than two points in this credit. Qualifying	2	**2**		

			initiatives may achieve additional points in other innovation credits, for the maximum of the five points available in total within the Innovation Category.				
Inn-2	**Exceeding Green Star Benchmarks**	To encourage and recognise projects that achieve environmental benefits in excess of the current Green Star benchmarks.	Up to two points can be awarded for an innovation initiative where there has been a substantial improvement on an existing Green Star credit, as follows: • One point for a solution that results in the elimination of the specific negative environmental impact of the project targeted by an existing credit; and • Two points for a solution that results in a substantial (e.g. 5% or greater above 'neutral') restorative environmental impact targeted by an existing credit. No individual initiative can achieve more than two points	2			

			in this credit. Qualifying initiatives may achieve additional points in other innovation credits, for the maximum of the five points available in total within the Innovation Category.				
Inn-3	**Exceeding Green Star Scope**	To encourage and recognise sustainable building initiatives that are currently outside of the scope of this Green Star rating tool but which have a substantial or significant environmental benefit.	One point can be awarded where:• An initiative in the project viably addresses a valid environmental concern outside of the current scope of this Green Star tool.No individual initiative can achieve more than one point in this credit. Qualifying initiatives may achieve additional points in other Innovation credits, for the maximum of the five points available in total within the Innovation Category.	1			
			Total Points =	**5**	**2**	**0**	

Green Star - Education v1

Credit Summary for: Rinker Hall

Category	Title	Credit No.	Points Available	Points Achieved	Points to be Confirmed
Management					
	Green Star Accredited Professional	Man-1	2	2	0
	Commissioning - Clauses	Man-2	2	2	0
	Building Tuning	Man-3	1	0	0
	Independent Commissioning Agent	Man-4	1	1	0
	Building Guides	Man-5	2	0	0
	Environmental Management	Man-6	2	0	0
	Waste Management	Man-7	2	2	0
	Learning Resources	Man-10	1	1	0
	Maintainability	Man-11	1	0	0
		TOTAL	14	8	0
Indoor Environment Quality					
	Ventilation Rates	IEQ-1	3	0	3
	Air Change Effectiveness	IEQ-2	2	0	2
	Carbon Dioxide Monitoring and Control and VOC Monitoring	IEQ-3	1	1	0
	Daylight	IEQ-4	4	1	1
	Thermal Comfort	IEQ-5	3	2	0
	Hazardous Materials	IEQ-6	1	0	0
	Internal Noise Levels	IEQ-7	2	0	2
	Volatile Organic Compounds	IEQ-8	4	4	0
	Formaldehyde Minimisation	IEQ-9	1	1	0
	Mould Prevention	IEQ-10	1	1	0
	Daylight Glare Control	IEQ-11	1	1	0

High Frequency Ballasts	IEQ-12	1	0	1
Electric Lighting Levels	IEQ-13	1	0	1
External Views	IEQ-14	1	1	0
	TOTAL	26	12	10
Energy				
Conditional Requirement	Ene-	Conditional Requirement	Yes	/
Greenhouse Gas Emissions	Ene-1	20	5	0
Energy Sub-metering	Ene-2	1	0	0
Peak Energy Demand Reduction	Ene-3	2	0	0
Lighting Zoning	Ene-4	1	0	0
Unoccupied Areas	Ene-7	2	0	0
Stairs	Ene-8	1	0	0
Efficient External Lighting	Ene-9	1	0	0
Shared Energy Systems	Ene-10	1	0	0
	TOTAL	29	5	0
Transport				
Provision of Car Parking	Tra-1	2	0	2
Fuel Efficient Transport	Tra-2	1	0	0
Cyclist Facilities	Tra-3	4	2	0
Commuting Mass Transport	Tra-4	5	4	0
Transport Design and Planning	Tra-6	1	0	0
	TOTAL	13	6	2
Water				
Occupant Amenity Water	Wat-1	5	4	0
Water Meters	Wat-2	1	0	0
Landscape Irrigation	Wat-3	3	3	0
Heat Rejection Water	Wat-4	4	4	0
Fire System Water	Wat-5	1	0	0
Potable Water Use in Laboratories	Wat-6	2	0	2
	TOTAL	16	11	2

Materials				
Recycling Waste Storage	Mat-1	2	1	0
Building Reuse	Mat-2	0	na	0
Recycled Content & Re-used Products and Materials	Mat-3	1	1	0
Concrete	Mat-4	3	0	1
Steel	Mat-5	2	2	0
PVC Minimisation	Mat-6	2	0	0
Sustainable Timber	Mat-7	2	2	0
Design for Disassembly	Mat-8	1	1	0
Dematerialisation	Mat-9	1	0	1
Flooring	Mat-11	3	0	0
Joinery	Mat-12	1	0	0
Loose Furniture	Mat-13	3	0	0
	TOTAL	21	7	2
Land Use & Ecology				
Conditional Requirement	Eco -	Conditional Requirement	Yes	/
Topsoil	Eco-1	1	0	0
Reuse of Land	Eco-2	1	1	0
Reclaimed Contaminated Land	Eco-3	2	0	0
Ecological Value of Site	Eco-4	4	1	0
	TOTAL	8	2	0
Emissions				
Refrigerant ODP	Emi-1	1	0	0
Refrigerant GWP	Emi-2	2	0	0
Refrigerant Leaks	Emi-3	2	0	0
Insulant ODP	Emi-4	1	0	0
Watercourse Pollution	Emi-5	3	2	0
Discharge to Sewer	Emi-6	3	0	0
Light Pollution	Emi-7	1	1	0
Legionella	Emi-8	1	1	0
	TOTAL	14	4	0

Sub-total weighted points:			**40**		**12**
Innovation					
Innovative Strategies & Technologies	Inn-1	5 points in total for Inn-1,2&3	2		0
Exceeding Green Star Benchmarks	Inn-2		0		0
Exceeding Green Star Scope	Inn-3		0		0
	TOTAL	5	2		0
Total weighted points:			**42**		**12**

Minimal standards for Green Star acreditation not met.

The GBCA does not endorse any self-assessed rating achieved by the use of Green Star - Education v1. The GBCA offers a formal certification process for ratings of Four Stars and above; this service provides for independent third party review of points claimed to ensure all points can be demonstrated to be achieved by the provision of the necessary documentary evidence. The use of Green Star - Education v1 without formal certification by the GBCA does not entitle the user or any other party to promote the Green Star rating achieved.

APPENDIX F
GREEN GLOBES RATING SYSTEM SCORECARD

CONSTRUCTION DOCUMENTS - NEW OR FULLY RENOVATED BUILDINGS

FINAL RATING SUMMARY OF POINTS

		Answer Rule	Points	Rinker	Gerson
A	**Project Management Policies and Practices**		**50**	**50**	**5**
A.1	**Integrated design process**		***20***		
A 1.1	Was an integrated design process used for the design development? (Yes / Partially / No)	Yes Partially	10 5	10	
A 1.2	Was a team approach used during the design process?	Y/N	5	5	
A 1.3	Was the green design facilitation process used to support green design integration?	Y/N	5	5	
A.2	**Environmental purchasing**		***10***		
A 2.1	Have aspects of green product specifications been incorporated?	Y/N	1	1	
	Give examples of specified products reflecting green specifications:	If Y and entered	2	2	
A 2.2	Was environmental purchasing integrated, including the procurement of energy-saving, high-efficiency equipment?	Y/N	7	7	
A.3	**Commissioning plan - documentation**		***15***		
A 3.1	Have the following best-practice, commissioning procedures been implemented?				
	A Commissioning Authority has been engaged.	Y/N	3	3	
	"Design Intent" and "Basis of Design" documentation has been reviewed.	Y/N	3	3	
	Commissioning requirements are included in the Construction Documentation.	Y/N	3	3	
	A Commissioning Plan has been developed.	Y/N	6	6	
A.4	**Emergency response plan**		***5***		
A 4.1	Does Division 1 include the project's environmental goals and procedures with regard to emergency response?	Y/N	5	5	5
B	**Site**		**115**	**90**	**39**
B.1	**Development area**		**30**		
B 1.1	Does the site plan indicate that the building is constructed on: (Select appropriate)				
	an existing serviced site?	Selected	20	20	20

	a remediated, previously contaminated site?	Selected	20		
	land with an existing minimum development density of 60,000 ft²/acre (i.e. two storey inner city development)?	Selected	20		
	a new greenfield site?	Selected	0		
B 1.2	Does the site plan show that the building is constructed on land that is neither a floodplain, nor a wetland, nor a wildlife corridor?	Y/N	5	5	5
B 1.3	Does the design accommodate the building's functions, while minimizing disturbance to the site's topography, soils and vegetation?	Y/N	5	5	
B.2	**Minimization of ecological impact**		**30**		
B 2.1	Are erosion control measures in place in accordance with best management practices (including during construction)?	Y/N	9	9	9
B 2.2	Will at least 35% of impervious surfaces be shaded - preferably with trees, shrubs or vines?	Y/N	7	7	
B 2.3	Do the construction documents specify measures to reduce heat build-up on the roof, either by using high-albedo roofing materials (reflectance of at least 0.65 and emissivity of at least 0.9) for a minimum of 75% of the roof surface, or by constructing a green roof, or by a combination of both high-albedo materials and green roof?				
	Yes - using high albedo materials	Selected, max	7	7	
	Yes - by means of a green roof	Selected, never in max	7		
	Yes - by a combination of high albedo materials and green roof	Selected, never in max	7		
	No	Selected, never in max	0		
B 2.5	Will the obtrusive aspects of exterior lighting such as glare; light trespass and sky glow be minimized and will the building design reduce collisions of birds with building?	Y/N/NA out	7	7	
B.3	**Enhancement of watershed features**		**15**		
B 3.1	Will storm water run-off be controlled to prevent damage to project elements and vegetation, and to minimize run-off into waterways such that: Select applicable for site conditions:				
	There is no storm water management.	Selected, never in max	0		
	Storm water is directed to pervious areas.	Selected, never in max	5		5
	In the case of a site which was previously 100% pervious (green site), there will be no increase in run-off.	Selected, never in max	10		

	In the case of a site whose pre-development impervious area is greater than 50% (site previously built on), a storm water control plan will achieve a 25% decrease in storm water run-off.	Selected, max	10	10	
	Select applicable for roof conditions:				
	There are no specific measures to reduce, control or direct run-off from the roof.	Selected, never in max	0		
	Run-off from the roof will be controlled and directed to a pervious area.	Selected, never in max	5		
	There will be a green roof.	Selected, max	5		
B.3.2	State the pre-development ratio of pervious to impervious area:	Not scored			
B.3.3	State the post-development ratio of pervious to impervious area:	Not scored			
B.4	**Enhancement of site ecology**		**40**		
B 4.1	Is the development occurring on a brownfield site that is being remediated?	Y/N	20		
B 4.2	Does the landscape plan create/preserve natural core and corridors and/or specify a naturalized landscape using native trees, shrubs and ground cover, with minimal lawn?	Y/N/NA out	20	20	
C	**Energy**		**365**	222	89
C.1	**Building energy performance**		**100**		
C 1.1	Have the energy performance targets been achieved?	Not scored			
C.1.2	Input the value of the projected annual energy use in kBtu.	Based on %age from C.1.3 if entered, else based on energy use per area per year from C.1.2 if entered.			
C.1.3	Input the value of the projected energy savings as a percentage compared to the reference base building. (Performance better than that of a building that meets the 75% target as defined by the EPA Energy Star Target Finder)				
	5% or more		10		
	10% or more		20		
	15% or more		30		
	20% or more		40		
	25% or more		50	50	
	30% or more		60		
	35% or more		70		
	40% or more		80		
	45% or more		90		
	50% or more		100		
	don't know		0		
C.1.4	Input the value of carbon dioxide (CO_2) emissions savings.	Not scored			
C.2	**Energy demand minimization**		**99**		

	Space Optimization		***10***		
C 2.1	Has the floor area been optimized to efficiently fulfill the building's functional and spatial requirements, including circulation and services, while minimizing the amount of space that will need to be heated or cooled?	Y/N/NA out	2		
	Describe how the space is being optimized:	If Y and entered / NA out	6		
C 2.2	Will the construction process be phased?	Y/N/NA out	2		
	Response to microclimate and topography		***24***		
C 2.3	Is the building sited and oriented to optimize the effect of microclimatic conditions for heating or cooling?	Y/N	2	2	
	Describe how the building is sited and oriented to optimize effects of microclimatic conditions:	If Y and entered	6	6	
C 2.4	Are site topography and design measures - including location and orientation - optimized to provide shelter from wind and snow deposition?	Y/N	8		
C 2.5	Does the building design maximize opportunities for natural or hybrid ventilation?	Y/N	2		
	Describe how the building design maximizes opportunities for natural or hybrid ventilation:	If Y and entered	6		
	Integration of daylighting		***35***		
C 2.6	Is daylighting maximized through building orientation, window-to-wall size ratios?	Y/N	5	5	
	Briefly describe the fenestration strategy:	If Y and entered	10	10	
C 2.7	Is window glazing which optimizes daylight (high visible transmittance (VT)) specified?	Y/N	2	2	
	Indicate the VT value:	If Y and entered	8	8	
C 2.8	Is electrical lighting integrated with daylighting, taking into account daily and seasonal variations?	Y/N	10	10	
	Building envelope		***30***		
C 2.9	Does the thermal resistance of the exterior enclosure meet Federal or State Energy Building Codes?	Y/N	2	2	2
	Indicate the R value for walls:	If Y and entered	4	4	
	Indicate the R value for the roof:	If Y and entered	4	4	
C 2.10	Do the construction documents indicate window glazing with a low U factor and window treatments that enhance interior thermal comfort?	Y/N	2	2	
	Indicate the window U value:	If Y and entered	8	8	

C 2.11	Do the construction documents specify measures to prevent groundwater and/or rain penetration into the building?	Y/N	5		
C 2.12	Is the integrity of the building envelope optimized, using the following best air/vapor barrier practices?				
	air barrier materials meet the requirements of local and national building codes	Y/N	2	2	2
	drawings provide air barrier detailing between components of the building envelope and around penetrations	Y/N	1	1	1
	mock-ups and mock-up testing is required for air and vapor barrier systems	Y/N	1		
	field review and testing is required for air and vapor barrier systems	Y/N	1		
C 2.13	Will the building design and construction prevent the “stack effect”?	Y/N/NA out			
	Energy metering		***0***		
C 2.14	Will major energy uses be sub-metered?	Y/N/NA out	0		
	List the major energy uses that will be sub-metered:	If Y and entered / NA out	0		
C.3	**Energy-efficient systems**		**66**		
C 3.1	Is the building's energy efficiency increased through the use of the following energy-efficient equipment?				
	Energy-efficient lighting fixtures, lamps and ballasts	Y/N	6	6	6
	Lighting controls	Y/N	6	6	
	Energy-efficient HVAC equipment	Y/N	6	6	6
	High efficiency (modulating or condensing) boilers	Y/N	8		
	High efficiency chillers	Y/N	6		
	Energy-efficient hot water service systems	Y/N	6	6	6
	Building automation systems	Y/N	6	6	
	Variable speed drives	Y/N	6	6	6
	Energy-efficient motors	Y/N	6	6	6
	Energy-efficient elevators	Y/N	4	4	4
	Others	Y/N	6		
	Describe:	If Y and entered	0		
B.4	**Renewable sources of energy**		**20**		
B 4.1	Do the construction documents indicate the integration of renewable energy sources?				
	Renewable energy will supply more than 10% of the total load	Selected, max	20		
	Renewable energy will supply more than 5% and less than 10% of the total load	Selected, never in max	10		

	No renewable energy	Selected, never in max	0		
C.5	**Energy-efficient transportation**		**80**		
	Public transport		***60***		
C 5.1	Will public transport be easily accessible within 500 yards of the building, and with service at least every 15 minutes during rush hour?	Y/N	50	50	50
C 5.2	Will there be designated preferred parking for car/van pooling and shelter from weather for persons waiting for a lift?	Y/N	6		
	Will there be alternative-fuel re-fueling facilities on-site or in the general vicinity?	Y/N/NA out	4		
	Cycling facilities		***20***		
C 5.3	Will there be safe, covered storage areas with fixed mountings to secure bicycles against theft?	Y/N	10		
C 5.4	Will there be changing facilities for building tenants and staff?	Y/N/NA out	10	10	
D	**Water**		**71**	62	22
D.1	**Water performance**		**30**		
D 1.1	Do water consumption estimations meet an established target of:	Based on level			
	Offices MURBs Schools, Universities:				
	< 35 gallons/ft²/year < 66,000 gallons/apt/year < 720 gallons/student/year		18		
	< 20 gallons/ft²/year < 33,000 gallons/apt/year < 900 gallons/student/year		24		
	< 10 gallons/ft²/year < 11,000 gallons/apt/year < 1150 gallons/student/year		30	30	
	No target has been set		0		
D.2	**Water-conserving features**		**31**		
	Minimal consumption of potable water		***16***		
D 2.1	Is there water sub-metering for high water-usage operations or occupancies?	Y/N/NA out	0		
	Which operations will be sub-metered?	If Y and entered / NA out	0		
D 2.2	Does the design include the following water-efficient equipment?				
	Low-flush toilets (less than 1.6 gallons/flush)	Y/N	4	4	4
	Water-saving fixtures on faucets (2.0 gallons/min) and showerheads (2.4 gallons/min.)	Y/N	4	4	4
	Water-saving devices or proximity detectors on urinals	Y/N/NA out	4	4	4
	Other water-saving appliances (For example low-flow kitchen faucets, low water consumption domestic and commercial dishwashers (8 gallons) and water efficient	Y/N/NA out	4		

(H-axis)washing machines).

	Briefly describe other water-saving measures:	Not scored			
	Minimal use of water for cooling towers		***0***		
D 2.3	Where wet cooling towers are used, do they have features to minimize the consumption of make-up water?	Y/N/NA out	0		
	Minimal use of water for irrigation		***15***		
D 2.4	Is a water-efficient irrigation system specified?	Y/N/NA out	5	5	
D 2.5	Will the landscaping use plants that are able to withstand extreme local weather conditions and that require minimal irrigation?	Y/N/NA out	5	5	5
D 2.6	Will non-potable water (i.e. captured rainwater or recycled site water) be used for irrigation?				
	Yes, 100% of the irrigation will consist of non-potable water	Selected, max, NA out	5	5	5
	Yes, irrigation consist of non-potable water, supplemented with potable water as needed	Selected, never in max	3		
	No				
	N/A				
D.3	**Minimization of off-site treatment of water**		**10**		
D 3.1	Is a graywater collection, storage and distribution system specified?	Y/N/NA out	5	5	
	Is an on-site wastewater treatment system specified?	Y/N/NA out	3		
	Briefly describe the on-site wastewater treatment:	If Y and entered / NA out	2		
E	**Resources - Systems and materials selection**		**100**	40	0
E.1	**Systems and materials with low environmental impact**		**35**		
E 1.1	Did the selection and specification process for the following assemblies and materials include a life cycle assessment of their environmental burden and embodied energy?				
	Foundation and floor assembly materials	Y/N	10		
	Structural systems (column and beam or post and beam combinations) and walls	Y/N	10		
	Roof assemblies	Y/N	10		
	Other envelope assembly materials (cladding, windows etc.)	Y/N	5		
	Specify:	If Y and entered	0		

E.2	**Materials that minimize consumption of resources**		**16**	
E 2.1	Will used building materials and components be integrated in construction?	Y/N	2	2
	Describe the types and quantities of used materials that will be integrated:	If Y and entered	2	2
E 2.2	Will building materials with recycled content be used in construction?	Y/N	2	2
	Describe the types and quantities of recycled materials that will be integrated:	If Y and entered	2	2
E 2.3	Are materials from renewable sources and/or locally manufactured materials specified and have these undergone a life-cycle assessment?	Y/N	2	2
	Describe the materials that will come from renewable or locally manufactured sources:	If Y and entered	2	2
E 2.4	Do the construction documents specify that tropical hardwoods will not be used and that solid lumber and timber panel products will originate from certified and sustainable sources (i.e. Sustainable Forestry Initiative, CSA, Forestry Stewardship Council, American Tree Farm System)?	Y/N	4	4
E.3	**Reuse of existing buildings**		**20**	
E 3.1	Do the construction documents indicate that the design includes existing façades in fully renovated buildings?			
	Less than 50%	Selected, never in max	0	
	At least 50%	Selected, never in max	5	
	At least 75%	Selected, never in max	8	
	100% of existing façades in fully renovated buildings	Selected, max	13	
E 3.2	Are 50% of the existing major structures (other than the shell) being reused?	Y/N/NA out	7	
E.4	**Building durability, adaptability and disassembly**		**14**	
E 4.1	Are durable and low maintenance building materials and assemblies specified?	Y/N	2	2
	Describe the materials and assemblies that have been specified for their durability and low maintenance:	If Y and entered	2	2
E 4.2	Do the construction documents indicate that the design promotes building adaptability?	Y/N	2	
	Describe the main features that promote building adaptability:	If Y and entered	3	

E 4.3	Does the design indicate that materials and fastening systems will allow for easy disassembly?	Y/N	2	2	
	Describe the features that allow disassembly:	If Y and entered	3	3	
E.6	**Reuse and recycling of construction/demolition waste**		**5**		
E 6.1	Is there a construction, demolition and renovation waste management plan?	Y/N	5	5	
E.7	**Facilities for recycling and composting**		**10**		
E 7.1	Do the construction documents indicate that adequate waste handling and storage facilities for recycling and composting are provided?	Y/N	5	5	
	Indicate how much storage area will be provided for storing recyclable waste:	If Y and entered	5	5	
F	**Emissions, Effluents and Other Impacts**		**50**	40	40
F.1	**Minimization of air emissions**		**0**		
F 1.1	Are low-NOx boilers and furnaces specified?	Y/N/NA out	0		
	Heat Input:	If Y and entered / NA out	0		
	Emissions:	If Y and entered / NA out	0		
F.2	**Minimization of ozone depletion**		**25**		
F 2.1	Are refrigeration systems specified that avoid the use of ozone-depleting substances (ODS) and potent industrial greenhouse gases (PIGGs) in the cooling systems?				
	Yes	Selected, never in max	20		
	No	Selected, never in max	0		
	There are no refrigerants	Selected, max	20	20	20
	Retro-fit	Selected, never in max	0		
	Indicate which refrigerant is specified:	Not scored			
F 2.2	In the case of a new building or a retro-fit, where CFC (chlorofluorocarbon), HFC (hydrocfluorocarbon) or HCFC (hydrochlorofluorocarbon) refrigerants are specified, what will be their ozone-depleting potential (ODP)?	Only scored if F.2.1 is answered No or Retro-fit			
	Higher than 0.05	Selected, never in max	0		
	Less than 0.05	Selected,	10		

	Equal to 0	never in max Selected, never in max	15	15	15
F 2.3	Do the construction documents indicate that the building's air-conditioning system complies with the requirements of ASHRAE 15 -1994?	Y/N/NA out	5	5	5
F.3	**Avoiding contamination of sewers or waterways**		**5**		
F 3.1	Are there measures to intercept and/or treat contaminated water to prevent contaminants from entering sewers or waterways?	Y/N/NA out	3		
	Briefly describe measures:	If Y and entered / NA out	2		
F.4	**Pollution minimization**		**20**		
	Compliant storage tanks		***0***		
F 4.1	Do the construction documents indicate that soil and surface water contamination will be prevented, in compliance with the federal and state regulations?	Y/N/NA out	0		
	Control other pollutants (PCBs, asbestos, radon)		***0***		
F 4.2	In the case of a retro-fit, do all PCBs present in the building meet applicable regulatory requirements?	Y/N/NA out	0		
4.2.2	In the case of a retrofit, do the construction documents require that the removal or abatement of asbestos and asbestos-containing materials meet all applicable state and local regulations?	Y/N/NA out	0		
F 4.3	Do the design and construction documents include measures appropriate to the region to prevent the accumulation of harmful chemicals and gases such as radon and methane in spaces below the substructure, and their penetration into the building?	Y/N/NA out	0		
	Integrated pest management		***10***		
F 4.4	Do the construction documents specify components, materials and the protection of structural openings to avoid infestation by pests?	Y/N	10		
	Storage and control of hazardous materials		***10***		
F 4.5	Do the construction documents include secure, appropriately-ventilated storage areas for hazardous and flammable materials?	Y/N	10		
G	**Indoor Environment**		**180**	63	18
G.1	**Effective ventilation system**		**50**		
G 1.1	Will the ventilation system be designed with the following features to avoid entraining pollutants into the ventilation air path?				

	To avoid re-entrainment, air intakes and outlets will be positioned at least 30 ft apart, and inlets will not be downwind of outlets.	Y/N	3	3	3
	Air intakes will be located more than 60 ft from major sources of pollution and at least the minimum recommended distances from lesser sources of pollution.	Y/N	3	3	3
	Air intake openings will be suitably protected.	Y/N	2	2	2
	Ventilation lining that will avoid the release of pollution and fibers into the ventilation air path.	Y/N	2		
G 1.2	Will sufficient ventilation be provided to obtain acceptable IAQ, in accordance with ANSI/ASHRAE 62.1-2004?				
	Yes, using the Ventilation Rate Procedure	Selected, max	*6*		
	Yes, using the Indoor Air Quality Procedure	Selected, never in max	*6*		
	No	Selected, never in max	*0*		
	Indicate ventilation rate:	If Yes and entered	4		
G 1.3	Is there evidence that the mechanical systems will provide effective air exchange?	Y/N	5		
	Describe how ventilation effectiveness will be achieved:	If Y and entered	5		
	Will there be indoor air quality monitoring?				
	Yes, using CO2 monitoring	Selected, max, NA out	*5*	5	
	Yes, using digital electronic airflow monitoring	Selected, never in max	*5*		
	No	Selected, never in max	*0*		
	N/A	Selected, never in max	*0*		
G 1.4	Will the mechanical ventilation system have the capability of flushing-out the building with 100% outside air at ambient temperatures above 32°F?	Y/N	5	5	
G 1.5	Will enclosed parking areas be mechanically ventilated?	Y/N/NA out	0		
G 1.6	Do the construction documents specify personal controls over the ventilation rates, or, in naturally ventilated buildings, operable windows or trickle vents on windows?	Y/N	3	3	
	Describe personal controls:	If Y and	2	2	

		entered		
G 1.7	Do the construction documents specify a Minimum Efficiency Reporting Value (MERV) of at least 13 (80-90% Dust Spot Efficiency) for air distributed to occupied spaces?	Y/N	5	5
G.2	**Source control of indoor pollutants**		**35**	
G 2.1	Are measures specified to prevent the growth of fungus, mold, and bacteria on building surfaces and in concealed spaces?	Y/N	5	
	Describe measures to prevent mold:	If Y and entered	5	
G 2.2	Are measures specified to ensure easy access to the air-handling units (AHUs), facilitating their drainage and preventing the accumulation of debris?	Y/N/NA out	5	
G 2.3	Do the construction documents specify the use of humidifiers that are designed to avoid the growth of microorganisms?	Y/N/NA out		
	Describe humidification system:	If Y and entered / NA out		
G 2.4	Do the construction documents specify CO monitoring in parking garages?	Y/N/NA out		
G 2.5	Do the construction documents indicate measures to mitigate indoor pollution at-source?	Y/N	2	2
	Describe measures to mitigate indoor pollution at source:	If Y and entered	3	3
G 2.6	Do the construction documents indicate that wet cooling towers are designed and located in such as way as to avoid the risk of Legionella?	Y/N/NA out		
G 2.7	Do the construction documents demonstrate that the domestic hot water system is designed to prevent the occurence of Legionella?	Y/N	5	
G 2.8	Do the construction documents specify interior materials that are low-VOC emitting, non-toxic, and chemically inert?	Y/N	5	5
	Describe some of the specified materials with these qualities:	If Y and entered	5	5
G.3	**Lighting**		**45**	
	Daylighting		***20***	
G 3.1	Do the construction documents show that the building provides ambient daylight to 80% of the primary spaces?	Y/N	5	
G 3.2	Will the building achieve a minimum daylight factor of 0.2 for a partially lit work place or living/dining area, or 0.5 for a well day-lit work area?	Y/N	2	
	Indicate daylight factor:	If Y and entered	3	
G 3.3	Are there views to the building exterior, or to atria from all primary interior spaces?	Y/N	5	5

G 3.4	Do the construction documents specify solar shading devices to enable occupants to control brightness from direct daylighting?	Y/N	5		
	Lighting Design		***25***		
G 3.5	Do the construction documents show that the building provides light levels no less than those recommended in IESNA Lighting Handbook, 2000, for the types of tasks that are anticipated in the various building spaces (regardless of the amount of natural light)?	Y/N	10		
G 3.6	Do the construction documents show that there are measures to avoid excessive direct or reflected glare, as per IESNA RP-5, 1999, Recommended Practice of Daylighting?	Y/N	5	5	
G 3.7	Are local lighting controls specified that relate to room occupancy, circulation space, daylighting and the number of workstations in office areas?	Y/N/NA out	10		
G.4	**Thermal comfort**		**20**		
G 4.1	Does the building design conform to the <i>ASHRAE 55-2004</i> for thermal comfort?	Y/N	20		
G.5	**Acoustic comfort**		**30**		
G 5.1	Is the building sited, and are spaces within the building zoned so as to provide optimum protection from undesirable outside noise, and fall within acceptable noise criteria (NC) ranges?	Y/N	5		
G 5.2	Do the construction documents specify the sound level transmission through the building envelope?	Y/N	2		
	Indicate the sound transmission class (STC) rating of the walls:	If Y and entered	3		
G 5.3	Do the construction documents include noise attenuation of the structural systems, and measures to insulate primary spaces from impact noise?	Y/N	2		
	Indicate the Field Input Insulation Class (FIIC) value:	If Y and entered	3		
G 5.4	Does the design provide acoustic controls to meet the acoustic privacy requirements?	Y/N	2		
	Describe how is acoustic control provided:	If Y and entered	3		
G 5.5	Does the interior design meet speech intelligibility requirements for the various spaces and activities?	Y/N/NA out	5	5	5
G 5.6	Does the design include measures to mitigate acoustic problems associated with mechanical equipment and plumbing systems?	Y/N	5	5	5
TOTAL			**931**	**567**	**213**
	Percentage			**0.609**	**0.2288**

APPENDIX G

DEUTSCHE GESELLSCHAFT FUR NACHHALTIGES BAUEN RATING SYSTEM SCORECARD

Main Criteria Group	Criteria Group	No.	Criterion	Criterion Points		Weighting	Weighted Points		Fulfilment	Points Group		Fulfilment (Group)	Weighting (Group)
				Achieved	Max. Possible		Achieved	Max. Possible		Achieved	Max. Possible		
Ecological Quality	Impacts on global and local environment	1	Global warming potential	10,0	10	3	30	30	100%	173,5	195	89%	22,5%
		2	Ozone depletion potential	10,0	10	0,5	5	5	100%				
		3	Photochemical ozone creation potential	10,0	10	0,5	5	5	100%				
		4	Acidification potential	10,0	10	1	10	10	100%				
		5	Eutrophication potential	7,1	10	1	7,1	10	71%				
		6	Risks to the regional environment	8,2	10	3	24,6	30	82%				
		8	Other impacts on the global environment	10,0	10	1	10	10	100%				
		9	Microclimate	10,0	10	0,5	5	5	100%				
	Utilization of resources and waste arising	10	Non-renewable primary energy demands	10,0	10	3	30	30	100%				
		11	Total primary energy demands and proportion of renewable primary energy	8,4	10	2	17	20	84%				
		14	Potable water consumption and sewage generation	5,0	10	2	10	20	50%				
		15	Surface area usage	10,0	10	2	20	20	100%				
Economical Quality	Life cycle costs	16	Building-related life cycle costs	9,0	10	3	27	30	90%	47	50	94%	22,5%
		17	Value stability	10,0	10	2	20	20	100%				

Socio-cultural and Functional Quality	Performance Health, comfort and user satisfaction	18	**Thermal comfort in the winter**	**10,0**	10	2	20	20	100%	**251,1**	**280**	**90%**	**22,5%**
		19	**Thermal comfort in the summer**	**10,0**	10	3	30	30	100%				
		20	**Indoor Hygiene**	**10,0**	10	3	30	30	100%				
		21	**Acoustical comfort**	**10,0**	10	1	10	10	100%				
		22	**Visual comfort**	**8,5**	10	3	26	30	85%				
		23	**Influences by users**	**6,7**	10	2	13	20	67%				
		24	**Roof design**	**9,0**	10	1	9	10	90%				
		25	**Safety and risks of failure**	**8,0**	10	1	8	10	80%				
	Functionality	26	**Barrier free accessibility**	**8,0**	10	2	16	20	80%				
		27	**Area efficiency**	**5,0**	10	1	5	10	50%				
		28	**Feasibility of conversion**	**7,1**	10	2	14	20	71%				
		29	**Accessibility**	**10,0**	10	2	20	20	100%				
		30	**Bicycle comfort**	**10,0**	10	1	10	10	100%				
		31	**Assurance of the quality of the design and for urban development for competition**	**10,0**	10	3	30	30	100%				
		32	**Art within Architecture**	**10,0**	10	1	10	10	100%				

Technical Quality	Quality of the technical implementation	33	**Fire protection**	**8,0**	10	2	16	20	80%	**74**	**100**	**74%**	**22,5%**
		34	**Noise protection**	**5,0**	10	2	10	20	50%				
		35	**Energetic and moisture proofing quality of the building's Shell**	**7,7**	10	2	15	20	77%				
		40	**Ease of Cleaning and Maintenance of the Structure**	**7,1**	10	2	14	20	71%				
		42	**Ease of deconstruction, recycling and dismantling**	**9,2**	10	2	18	20	92%				

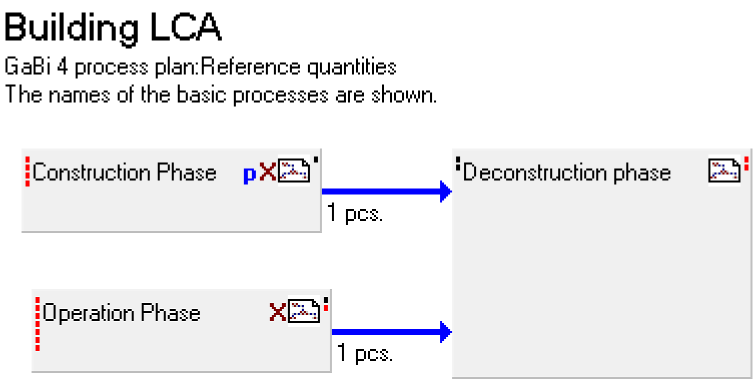
Quality of the Process	Quality of the planning	43	Quality of the project's preparation	8,3	10	3	25	30	83%	188,6	230	82%	10,0%
		44	Integrated planning	10,0	10	3	30	30	100%				
		45	Optimization and complexity of the approach to planning	8,6	10	3	26	30	86%				
		46	Evidence of sustainability considerations during bid invitation and awarding	10,0	10	2	20	20	100%				
		47	Establishment of preconditions for optimized use and operation	5,0	10	2	10	20	50%				
		48	Construction site, construction phase	7,7	10	2	15	20	77%				
		49	Quality of executing companies, pre-qualifications	5,0	10	2	10	20	50%				
	Quality of the construction activities	50	Quality assurance of the construction activities	10,0	10	3	30	30	100%				
		51	Systematic commissioning	7,5	10	3	23	30	75%				

Quality of the Location		56	Risks at the microlocation	7,0	10	2	14	20	70%	93,3	130	72%
		57	Circumstances at the microlocation	7,1	10	2	14,2	20	71%			
		58	Image and condition of the location and neighbourhood	1,0	10	2	2	20	10%			
		59	Connection to transportation	8,3	10	3	24,9	30	83%			
		60	Vicinity to usage-specific facilities	9,7	10	2	19,4	20	97%			
		61	Adjoining media, infrastructure development	9,4	10	2	18,8	20	94%			

APPENDIX H

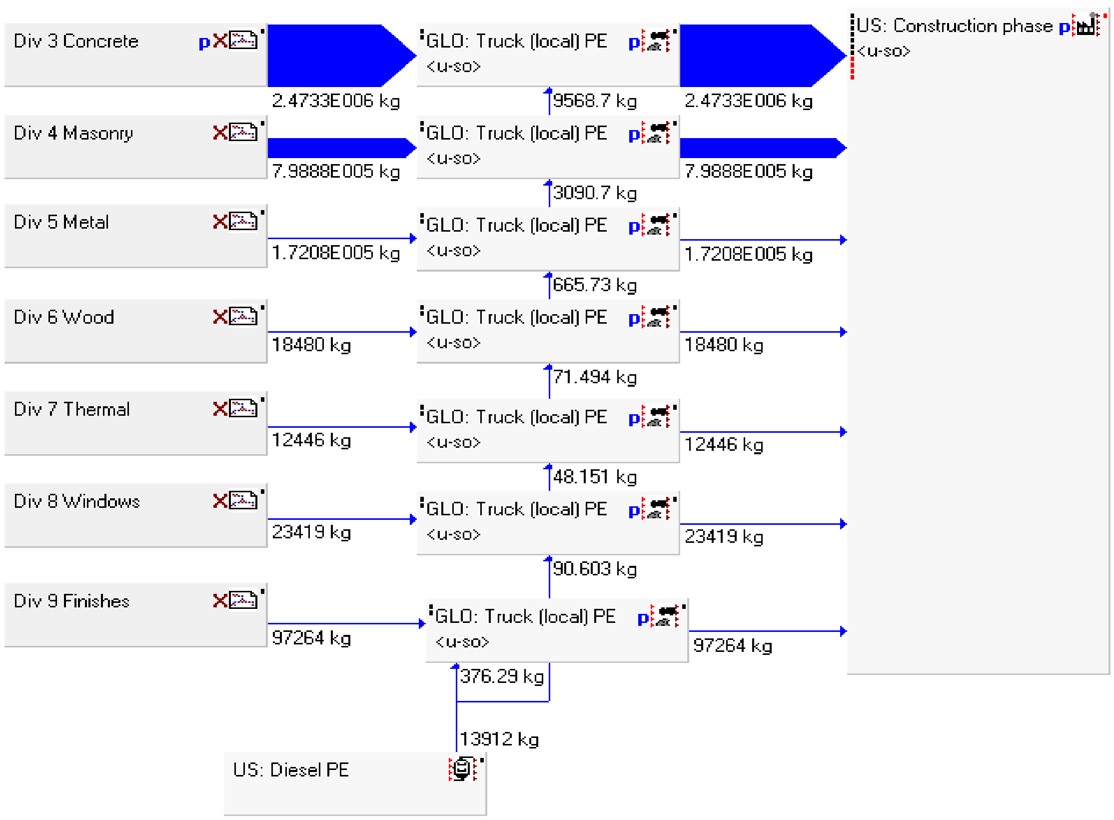
LIFE CYCLE ASSESSMENT FOR BUILDING RATING SYSTEM MODEL ELEMENTS

The following graphics depict the modules from the LCABRS program that were developed in conjunction with this research:



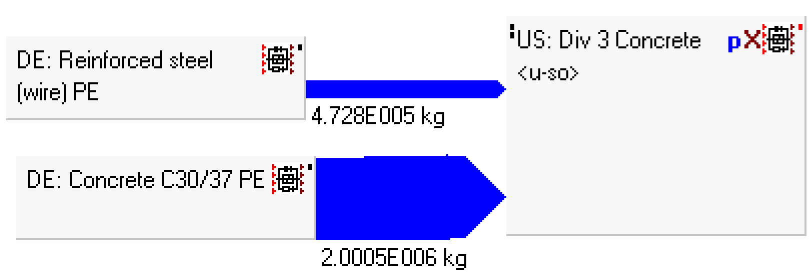
Construction Phase p

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



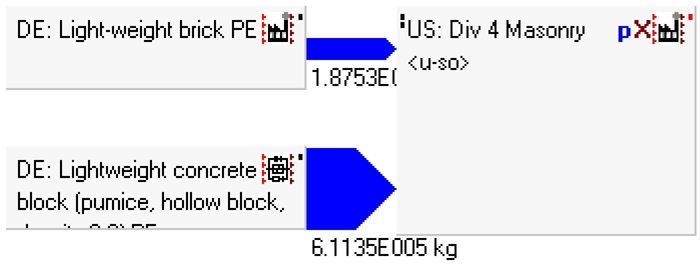
Div 3 Concrete p

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



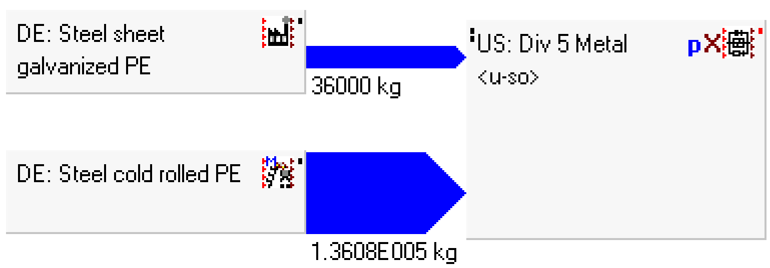
Div 4 Masonry

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



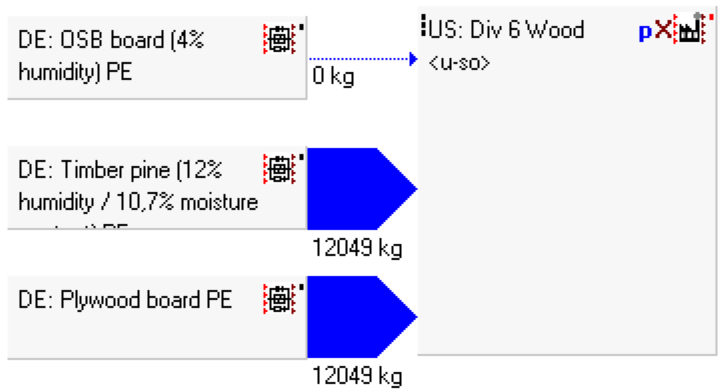
Div 5 Metal

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



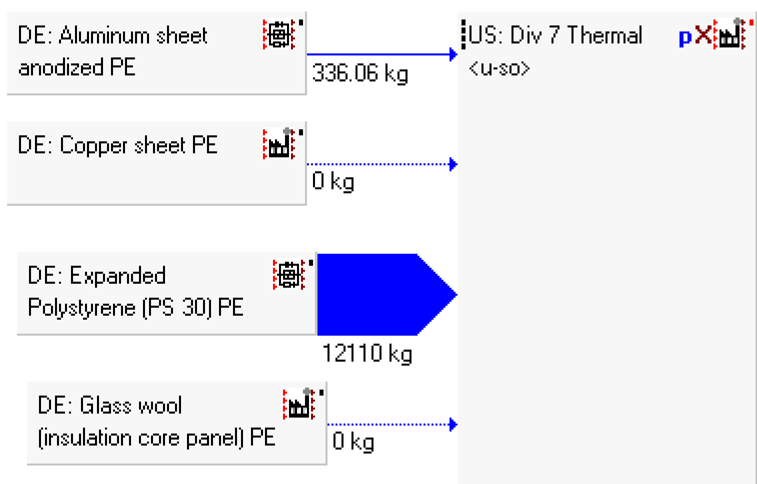
Div 6 Wood

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



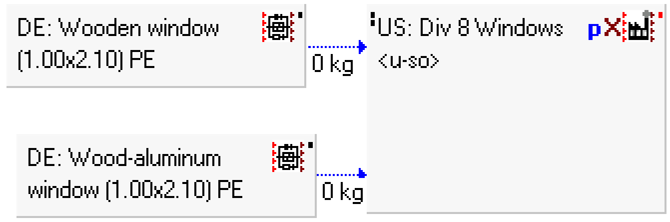
Div 7 Thermal

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



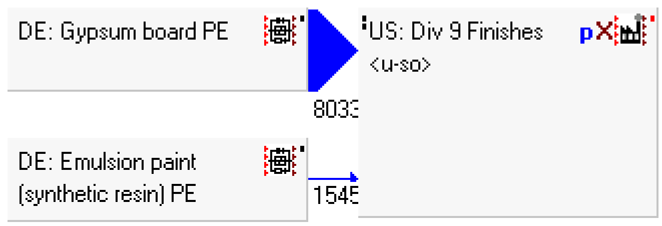
Div 8 Windows

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



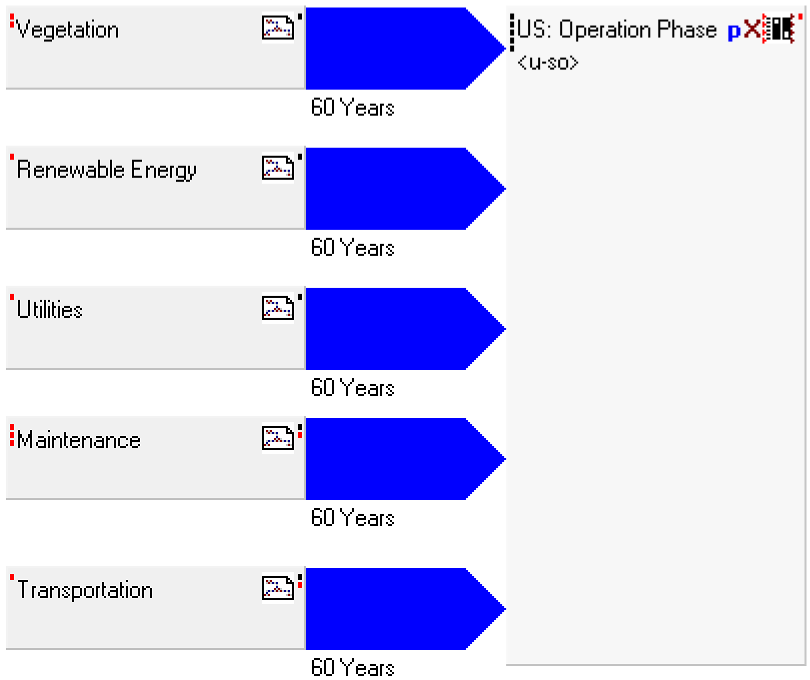
Div 9 Finishes

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



Operation Phase

GaBi 4 process plan: Time [Years]
The names of the basic processes are shown.

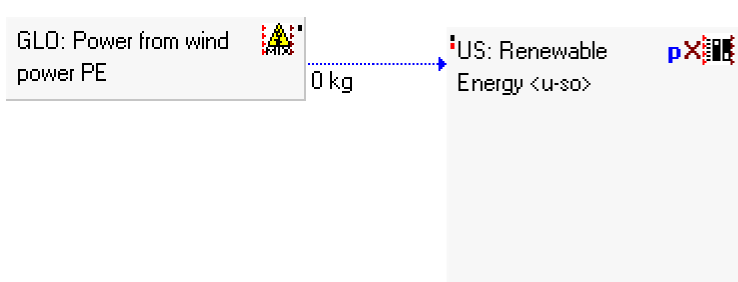


Vegetation

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.

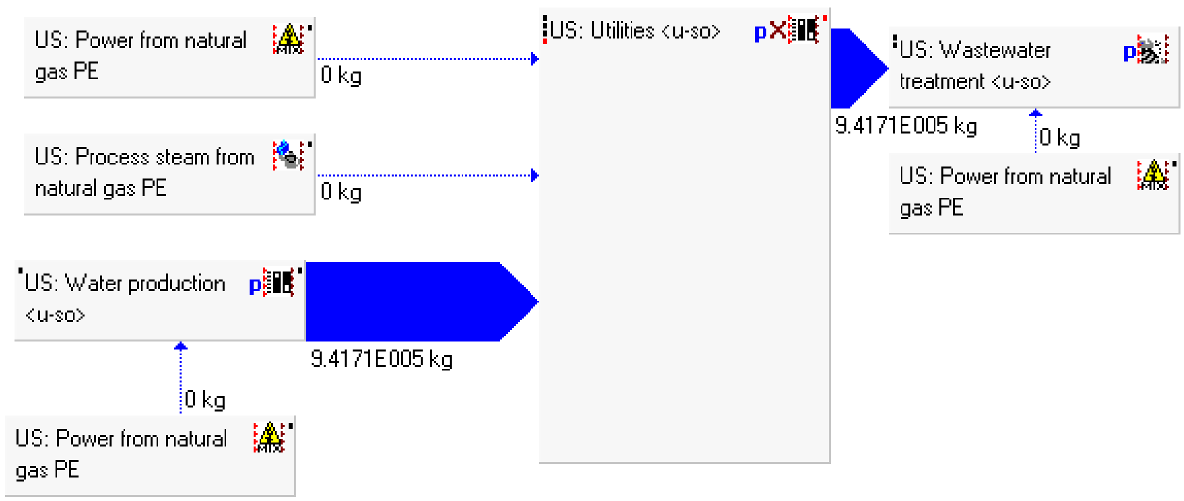
Renewable Energy

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



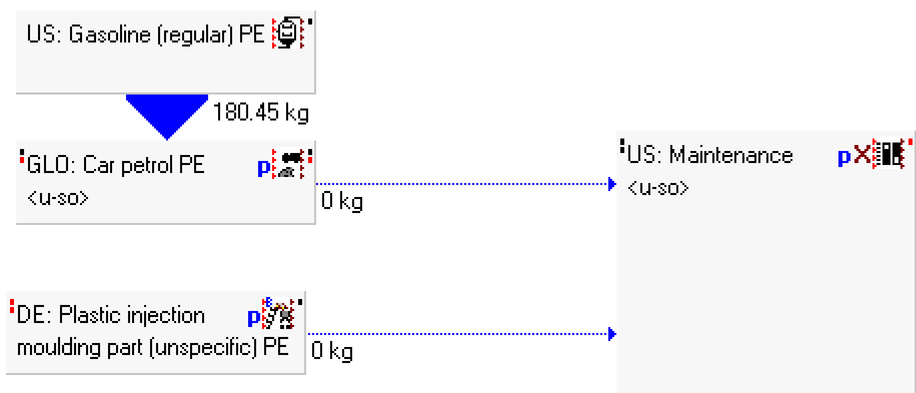
Utilities

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



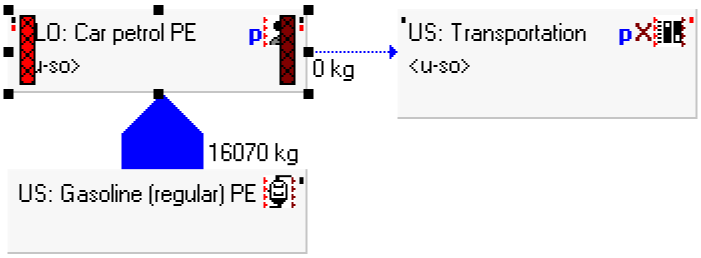
Maintenance

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



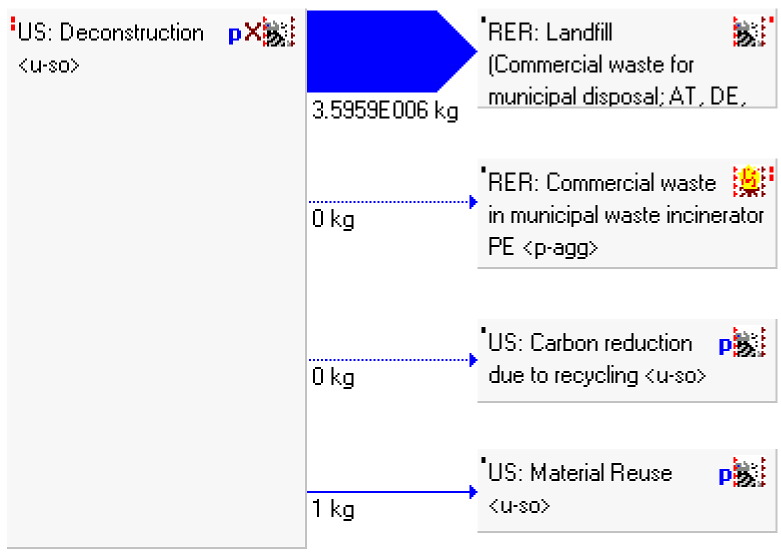
Transportation

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



Deconstruction phase

GaBi 4 process plan: Mass [kg]
The names of the basic processes are shown.



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BIOGRAPHICAL SKETCH

Mark Russell has focused his career on the built environment and facility management. With a bachelor's degree in electrical engineering and a master's degree in environmental engineering he became interested in sustainable methods to consider energy use and production. Following numerous years working in the construction industry, he saw the need to expand his research interest in the application of methods to determine the effectiveness of building energy savings. After returning to study for his doctorate, he worked extensively with the Green Globes and Leadership in Environmental and Energy (LEED) rating systems and performed numerous on site building evaluations throughout the United States. Mr. Russell received his Ph.D. from the School of Building Construction at the University of Florida in the summer of 2011.