UNDERSTANDING AND IMPROVING GREEN BUILDING STANDARDS IN HONG KONG

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Submitted to:

Professor Zhikun Hou
Professor Constance Clark

In Cooperation With

Ir. Dr. Eddy Lau
Hong Kong Green Building Council

John Crespi
Physics

Ryan Rangle
Mechanical Engineering

Christina Webb
Computer Science

Lili Zhang
Industrial Engineering and Mathematical Sciences

Professor Zhikun Hou, Advisor
Department of Mechanical Engineering

Professor Constance Clark, Co-Advisor
Department of Humanities and Arts

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Authorship Page

Ryan Rangle: The title page, the executive summary, abstract, background sections "History of BEAM," "Defining other Hong Kong Building Standards," "Differing Adherence between BEAM Credits," "Definition of a 'Credit'", Appendix A, Bibliography, organized the Results section, took both written notes and electronic recordings of the focus group, and aided in tasks such as surveying occupants of BEAM buildings and performing data analysis.

Christina Webb: Table of contents, list of figures, list of tables, background sections "Relationships between BEAM and International Standards," "History of BEAM," Appendix E, and general formatting. Took notes during the focus group and any important meeting. Worked in conjunction with the other teammates to perform data analysis and survey occupants of BEAM buildings.

John Crespi: Background sections "Importance of Green Building Standards" and "Unique Aspects of BEAM." The primary writer of the methodology. Moderated the focus group and conducted interviews during site visits. Worked in conjunction with other teammates to perform data analysis and survey occupants of BEAM buildings.

Lili Zhang: Worked in conjunction with other teammates to perform data entry and analysis as well as survey the occupants of BEAM certified buildings. Wrote and updated several papers of detailed data analysis such as "Platinum Buildings Detailed Analysis Report" and "Sustainable Building Report," which are all confidential. Worked with teammates in writing and compiling the Results section. Translated the English version of the occupant survey into Chinese.

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Executive Summary

This project, sponsored by the Hong Kong Green Building Council, was about improving green building standards in Hong Kong, specifically the BEAM (Building Environmental Assessment Method) Plus standard. In the course of improving this standard, the project identified which credits have low and high adherence, why certain credits fail to be satisfied or are too easily satisfied, and how to increase the achievement of all credits. The project also sought to add a number of credit requirements to BEAM Plus that would improve the rating system. Climate change is a serious issue facing the earth and sustainable development is critical to the curbing of global warming. Buildings are a major source of environmental detriment, causing problems such as noise, water, and air pollution. To be able to combat these problems and in turn to improve BEAM Plus, this project examined international standards such as BREEAM, LEED, and others that have made positive impacts in the world. In addition, a study of other building standards that are used in Hong Kong was conducted to gain a better understanding of the problems distinct to the local climate, economy, and culture. These steps were necessary to have a solid foundation on which the team could build the rest of the project.

To gather data on any deficiencies in the BEAM Plus standard, this project used proven methods of data gathering. First, a focus group was held consisting of BEAM practitioners, those who have in-depth knowledge of BEAM Plus and who aid buildings in becoming certified. They offered valuable opinions on the strengths and weaknesses of many BEAM Plus credits. Second, interviews were conducted with building owners to gain insight on how the BEAM Plus standard has improved their buildings. Their knowledge and opinions were crucial to establishing the difficulties that are present in the implementation of BEAM Plus and finding solutions to these problems. Third, surveys were presented to occupants of BEAM Plus certified buildings, in order to see how the standard affects them practically in their everyday lives. In addition, their responses on their personal feelings toward a building being BEAM Plus certified helped to determine the general desirability of living and/or working in a BEAM Plus building. Lastly, observations of BEAM Plus buildings were conducted, which consisted of visually checking that the technologies that were implemented when the building was first certified were still in place and having their desired effect. Through these methods, the project was able to determine the strengths and weaknesses of various BEAM Plus credits and formulate a series of recommendations to improve the BEAM Plus standard.

The team focused on the following major areas within BEAM Plus: highly contested credits, low achievement credits, high achievement credits, and high achievement bonus credits. The team formulated solutions for how each of the credit requirements within these areas should be improved. For highly contested credits, the team frequently suggested rewording credit descriptions and adding more specifics and definitions to increase clarity for the building designers. The recommended changes to low achievement credits were generally to divide a credit into smaller, more manageable sub-credits and decrease credit thresholds when they were set unrealistically high. The general changes to highly achieved credits were to combine them with similar credits to both decrease their effective point value and increase any thresholds that exist for achieving them. For highly achieved bonus credits, it was generally recommended that they be made into normal credits because they are no longer difficult enough to be in the bonus category. Overall, these changes would increase the rigorousness of the BEAM system and further allow buildings to preserve the environment.

The team also recommended a number of other changes to the BEAM system. First it is recommended that five new credits be added to the BEAM scheme: “Cultural Consciousness”, “Quality Public Spaces”, “Environmental Product Declaration”, “Ergonomics, User Friendliness, and User Education of Green Technologies”, and “User Feedback and Fine-Tuning After Occupancy”. These three credits are designed to add new aspects to BEAM by addressing the distinct culture of Hong Kong, the community impact of BEAM buildings, and a new way to classify materials that are better for the environment. Along with these additional credits, the team also suggests that the weighting for material aspects is increased from 8% to 10%, while the weighting for site aspects is lowered from 25% to 23% to help increase achievement for material aspect credits. This percentage was taken directly from advice by BEAM Practitioners in the focus group. Lastly, the team suggests a change to the requirements to achieve the Unclassified rating of BEAM Plus, requiring 10% of available credits instead of 0%, so the buildings must put in appropriate effort to gain any level of BEAM Plus certification.

Abstract

This project, sponsored by the Hong Kong Green Building Council, is to improve green building standards in Hong Kong, specifically the BEAM (Building Environmental Assessment Method) Plus standard. In the course of improving this standard, the project identified which credits have low adherence, which credits have high adherence, why certain credits fail to be satisfied, and how to increase the achievement of all credits. This project examined international standards such as BREEAM, LEED, and others that have made positive impacts elsewhere as well as other standards that are specific to Hong Kong. To gather data on any deficiencies in the BEAM Plus standard, the project conducted focus groups with BEAM Plus practitioners, interviews with building management and operators, surveys with building occupants, as well as observations of certified buildings. The team obtained final results through completing these tasks. These results were used to guide recommendations for improvements to three areas of the BEAM Plus system, to increase the achievability of the lowest adherence credits through making them more realistic in expectation, to increase the rigorousness of the most frequently achieved credits by decreasing the number of available points and making their requirements more stringent, and to decrease the number of contested credits by increasing the specificity of the BEAM Plus guide book. In addition, the team recommends new credits to be added to BEAM Plus that take into account human comfort and certified buildings as well as a few changes to the scoring system as a whole.

1. Introduction

It is crucial for humanity to protect the world from environmental destruction, for we as humans rely on the environment for everything we have, the food we eat, the air we breathe, the water we drink, and the buildings we live in. With resources becoming more and more scarce, no longer can a building be built with disregard to the areas of sustainability and efficient design. Thus, green buildings have become a major focus of governments around the world. One effective way to reduce society's environmental footprint is by constructing and operating buildings in environmentally friendly ways. Green building construction not only reduces the amount of resources we need to extract from the earth, but also improves the quality of life for people who live and work in and around these buildings.

With the industrialization of China over the past few decades, a new global competitor has emerged along with another potential source for negative environmental impact. While advances in green design are currently happening in China, such as a building in Beijing that won China's first ever Leadership in Energy and Environmental Design (LEED) gold certification in 2005, as well as the country's first Green Building Innovation Award, China still has a way to go before implementing green standards in the majority of their buildings. It is important that China, like the rest of the industrialized world, adopt widespread practices and policies that make their economy and infrastructure more sustainable.

On the southern periphery of China, Hong Kong has become a "vertical city," housing the majority of its population in skyscrapers. With a very small amount of buildable land, the Hong Kong government has focused on making these existing buildings environmentally friendly and sustainable, to improve and prolong their useful life. In an effort to make a set of standards for green buildings to abide by, the BEAM (Building Environmental Assessment Method) scheme was established in 1996 by the Real Estate Developers Association. It was upgraded to fit more modern buildings in 2004 and further developed into the BEAM Plus standard in 2009. BEAM Plus standards cover six specific aspects of a building: site aspects, material aspects, energy use, water use, indoor environmental quality, and innovations and additions. The benefit to achieving any level of BEAM certification is twofold. One, the building gains a public reputation for implementing green technologies and practices, and two, the building are able to claim a Gross Floor Area (GFA) concession. Since the establishment of BEAM Plus, over 300 building projects in Hong Kong have become BEAM Plus certified at all levels.

Although BEAM Plus is a helpful and useful tool, there are a few problems. One, in previous versions of BEAM, it was possible for a building project to focus on easy, cheap credits to obtain BEAM certified status, all while ignoring credits that inherently are more environmentally beneficial, but harder to achieve. This phenomenon is called “green washing”. Two, there is a major discrepancy between which of the credit requirements are actually put into practice. These standards range from benchmarks for water use, to implementation of renewable materials, to efficient energy practices. Why do some buildings follow certain standards while ignoring others? What are the reasons for doing so? How can ignored standards gain better adherence, as in, be satisfied more often? The problem that must be addressed concerns the reasoning for these discrepancies and what can be done to make BEAM Plus more meaningful and practicable.

2. Background

For the team to effectively improve the BEAM Plus scheme, it was necessary to first conduct a large amount of research, not only into BEAM Plus, but also into other green building standards that apply to Hong Kong. In order to fully comprehend the importance of the project, the team first looked into the effects that building construction and operation had on the environment. The team then looked at the history of BEAM Plus to understand its origins so that the team could develop a better plan for its future. Also important to understanding BEAM Plus was researching how it related to other green building standards around the world and how it is unique to Hong Kong. Lastly, the team looked at the data collected from previous BEAM Plus credit achievement studies to get to know credits that they would possibly need to address in their research.

2.1 Importance of Green Building Standards

Green building standards are important because the earth's environment is significantly affected by human behavior, with buildings being substantial contributors to humanity's overall environmental impact. Building construction, operation, and maintenance consumes a large amount of electricity, making it important to address energy consumption with environmental building standards. Green building standards also serve the purpose of encouraging the use of recyclable and renewable materials. Modern buildings must additionally employ technology to conserve the amount of water consumed. Lastly, buildings should not have a large impact on the microclimate around the building. Overall, green building standards exist to address the environmental impact of a building and to encourage environmentally responsible behavior (Huang et al, 2013).

Building construction is one piece of the larger puzzle of environmental protection. As more and more buildings consume resources, mines must dig deeper to extract more metals, minerals, and fossil fuels. This extraction destroys local environments, and the burning of that fuel releases greenhouse gasses as well as other pollutants. A breakdown of energy consumption in buildings can be seen in Figure 1.

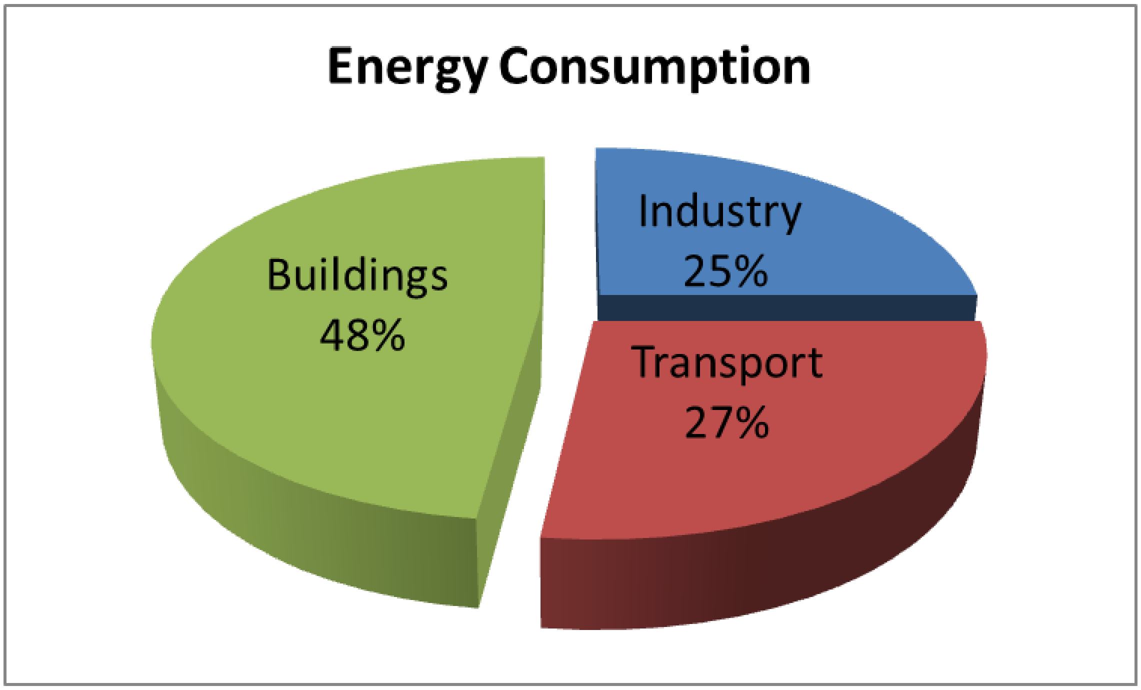

Figure 1: Distribution of Energy Consumption in Buildings ("Buildings energy data," 2011)

The energy industry is a significant polluter in the modern world. The extraction of fossil fuels is an activity that significantly degrades the quality of the local environment. Extraction methods such as mountaintop removal permanently change the local landscape. Oil wells have the potential to cease functioning properly and leak, releasing millions of gallons of oil into the environment. When wells function properly, the fuels typically then enter a pipeline to travel to a refinery. Pipelines are also not foolproof and do occasionally leak oil, which can contaminate local water supplies. When the fuel arrives at the refinery, it is processed. However, these facilities release very high levels of carcinogens that can be detrimental to both the people in the surrounding area as well as the local environment. The fuel is then transferred, using combinations of truck, rail, and ship, causing emissions as they move across the world and creating the potential for spills if accidents occur. Finally, when the fuel is consumed, it releases greenhouse gasses and other harmful toxins that can cause health problems in humans as well as global warming (EESI).

Other forms of energy production can be just as detrimental to the environment. Current methods for uranium extraction leave behind large amounts of waste. In addition, once the fuel is consumed in a nuclear plant, it must be disposed of. Unfortunately, nuclear fuel stays harmful for thousands of years after it has been used. Another method of energy production, hydroelectric, does not release greenhouse gasses, but it can make fish migration difficult and has the potential to interrupt the natural flooding that many river ecosystems are dependent on. Large scale energy production has a number of environmental problems associated with it and buildings can help to reduce the energy produced at large facilities (EESI).

Buildings can reduce the power drawn off of the electrical grid by installing their own forms of energy production, such as those that concern solar power. This can take the form of photovoltaic cells on a building which would enable it to take advantage of solar energy. Another common way to use this type of energy is to heat water. This reduces the amount of electricity used by water heaters. Both are effective methods of utilizing the sun to reduce the energy consumption of a building and lessen the usage of other harmful sources of electricity. It is important for buildings to conserve energy, not only so that fewer greenhouse gasses are released from the burning of fossil fuels, but to reduce the amount of fuel extraction, transportation, and refining that takes place (Chaudhari et al, 2013).

Green building standards also involve the materials used for construction, since raw material extraction can be detrimental to the environment. The refinement of many metals and other substances uses a significant quantity of toxic chemicals, making it important to use as many recycled materials in a building as possible. These recycled materials reduce the amount of resource extraction and make use of materials that would otherwise be discarded. The BEAM Plus standards not only include credits for the use of recycled materials, but also encourage efficient demolition practices (Huang, 2013).

The use of recycled materials is not the only aspect of green building construction that is concerned with materials use. Green building standards also include provisions for using renewable materials. Renewable materials are materials that can be easily replaced once they have been used. However, not all renewable materials are the same. Some materials that fall in this category, such as oak wood, can take a long time to renew. On the other hand, a material like bamboo can grow back quickly after being harvested. BEAM Plus encourages the use of rapidly renewable materials over any slowly renewable material because the faster an environment can return to a more natural state, the less of an impact the resource extraction will have (Huang et al 2013).

It is important to reduce the amount of water consumed by a building because water is a scarce resource. A reduction in water demand bears a number of beneficial effects. For example, there will be less sewage that has to be treated so fewer sewage treatment facilities have to be produced. It also means that, if there were a drought, the reduced amount of water would be able to service more people. There are a number of ways to implement the conservation of water. One effective way is to recycle gray water (waste water from showers, washing machines, etc.) for uses such as watering plants. Another way to decrease water consumption is to install water efficient appliances, which could save over 30% of water consumed compared to an average building. Early leak detection technology is not only an effective way to conserve water, but also reduces potential water damage to a building. Overall, efficient water conservation is an important aspect of creating sustainable buildings (Rogers and Hall, 2003).

Green building standards also address the environmental impact that a building has on the area immediately surrounding the building. This area is affected by the construction process as well as by the resulting building, and it is the goal of BEAM Plus to reduce that impact as much as possible. The construction process of a building can have a number of effects on the surrounding area, possibly creating air, water, and noise pollution. Runoff from building construction can also contain toxic chemicals, which could run into the local water supply and potentially harm those downstream of the construction site. The exhaust fumes and dust produced by building construction are also sources for polluting the local air. These air pollutants can cause breathing problems for the people who work and live in the area surrounding the building. Lastly, noise pollution, while not as much of a health risk, does significantly reduce the quality of life for those near the building.

It is important to remember that a building does not cease its effect on the local environment after its construction. A building can have a perpetual impact on the surrounding area through changing wind speed, temperature, and blocking light from the sun. Buildings, especially in an urban setting, can redirect wind, which can greatly increase local wind speeds or stop wind entirely. If the wind becomes too strong, then it can become uncomfortable for pedestrians. On the other hand, if the wind becomes stagnant, then the exhaust from cars and other air pollution will not be blown away, greatly decreasing the air quality of the area. Buildings can also contribute to increasing the local temperature and cause the urban heat island effect, which is generated by the use of dark colored materials which absorb solar energy easily and radiate it back to the city (as opposed to light materials which reflect energy). In addition, a large building can impact the amount of sunlight that reaches the surrounding area. This blockage can have an impact on surrounding buildings such as hospitals, schools, and residential areas. A completed building, simply by existing, can have a substantial effect on the local microclimate and neighboring structures (Beam Society, 2012).

Buildings are a large contributor to the environmental footprint that humans leave. Green building standards are designed to reduce that footprint by making their construction and operation more sustainable. Without green buildings, protecting the environment and maintaining modern human behavior well into the future becomes much more difficult if not impossible.

2.2 History of BEAM

BEAM is a voluntary assessment scheme for green buildings first created in December 1996 by the Real Estate Developers Association and operated by the Center for Environmental Technology Limited. It is now maintained by the BEAM Society with the scheme operation taken up by the Hong Kong Green Building Council (Ma, 2009, p. 1873). BEAM was heavily influenced by the structure of the United Kingdom's green building standard, the Building Research Establishment Environmental Assessment Method (BREEAM). As such, the structure of BEAM is organized into six specific areas: site, material, water, energy, indoor environmental quality, and innovations and additions.

In these six areas, over 100 best practice environmental criteria concerning key aspects of buildings in Hong Kong are defined. The more criteria a building is able to satisfactorily meet, the higher the level of certification the building will receive, ranging from Unclassified to Platinum. On a per capita basis, HK-BEAM is one of the most widely used green building assessments and labeling schemes in the world (Ma, 2009, p. 1873).

BEAM began with two versions, 1/96 for new buildings and 2/96 for existing buildings. In 1999, a new version was released, 3/99, for residential buildings. In 2005, the method was updated and versions 4/04 for new buildings and 5/04 for existing buildings were created. They originated from a pilot version from 2003 that was reviewed and researched by the BEAM Society Technical Review Panel to figure out how to improve the standard (Society, 2012). Changes were made to expand the range of building types that could be assessed and to include topics such as building quality and sustainability. The most important change was the new assessment method that it used, called the energy budget approach. This approach was created by calculating the yearly energy use for a building and comparing the results to the energy use of a simulated "baseline" building, or a building with no changes made to it. The energy budget approach worked very well for BEAM, so it was kept in the latest version of BEAM, BEAM Plus, which was created in 2010 (Chen & Lee, 2013).

BEAM Plus came about from the international realization that climate change and global warming were real, pressing issues. Countries around the world knew that they all had to cooperate and contribute to solve this issue, so the creators of BEAM developed the standard further to meet the growing expectations of other countries. In 2010, their labors produced BEAM Plus version 1.1 (Chen & Lee, 2013).

2.3 Relationships between BEAM and International Standards

In any study of BEAM standards, one must examine other major green building standards in use around the world. The United Kingdom's Building Research Establishment Environmental Assessment Method (BREEAM), the United States' Leadership in Energy and Environmental Design (LEED), Japan's Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), China's Evaluation Standard for Green Buildings (also known as Three Star), and Australia's GREEN STAR are all useful standards to compare to BEAM in order to see how each approaches environmental sustainability.

The first green building assessment scheme in the world, and the inspiration that gave birth to BEAM, BREEAM was established in 1990 by the Building Research Establishment (BRE) and is the most widely used environmental rating scheme in the United Kingdom (Lee, 2008, p. 1882). It uses the official U.K. Building Regulation as a benchmark from which to rate the level of performance improvement. An important aspect of BREEAM is its method of energy assessment, called "Credit Ene 1-Reduction of CO2 emissions". The energy performance of a given building is shown as a CO2-based index, which is calculated using a similar, accepted reference building and comparing emissions. This heavy focus on CO2 is unique to BREEAM (Roderick, 2009, p. 1167).

One of the most widely recognized assessment schemes in the world, LEED was developed by the US Green Building Council in 1998 for the US Department of Energy. There are multiple versions of LEED that exist for different buildings, such as new buildings, existing buildings, schools, homes, interior construction, and neighborhood development. However, there are two main approaches to assess building energy performance under LEED, the Prescriptive

Compliance Path (PCP) and the Whole Building Energy Simulation (WBES). The PCP uses prescriptive measures defined in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Advanced Energy Design Guide for Small Buildings 2004, while the WBES uses a comparison against a "normalized" building to judge improvements on energy costs. In addition, the WBES requires the use of a complex simulation program that can perform thermal analysis to the specifications outlined in the ASHRAE Standard 90.1-2004 Appendix G, also known as the Performance Rating Method (PRM). Two buildings are modeled in the simulation: the building that is being scrutinized and a baseline model building. The energy rating is calculated based on the annual energy cost of running the scrutinized building against the baseline building, using current rates for purchased energy or state average energy prices (Lee, 2008, p. 1168). LEED has helped inspire other countries to develop their own assessment schemes, such as the ESGB (Evaluation Standard for Green Buildings) in China (Chen & Lee, 2013, p. 129).

CASBEE (Comprehensive Assessment System for Built Environment Efficiency) is Japan's assessment scheme for green buildings, which was created in 2001. Unlike BEAM, CASBEE was not an assessment adopted from the BREEAM assessment scheme. It has four versions that relate to a building's cycle: pre-design, new construction, and renovation. Another difference between CASBEE and BEAM is the scoring scale. While BEAM uses a point system based on what criteria are completed, CASBEE uses a ratio system known as Building Environmental Efficiency (BEE). It uses this system to determine a building's score by dividing the Quality Factor by the Loading Factor. The Quality Factor is the improvement for the user in their private property, while the Loading Factor is the negative aspects of the public property outside, as seen in Figure 2 below (Ng, Chen, & Wong, 2013, p. 14-15).

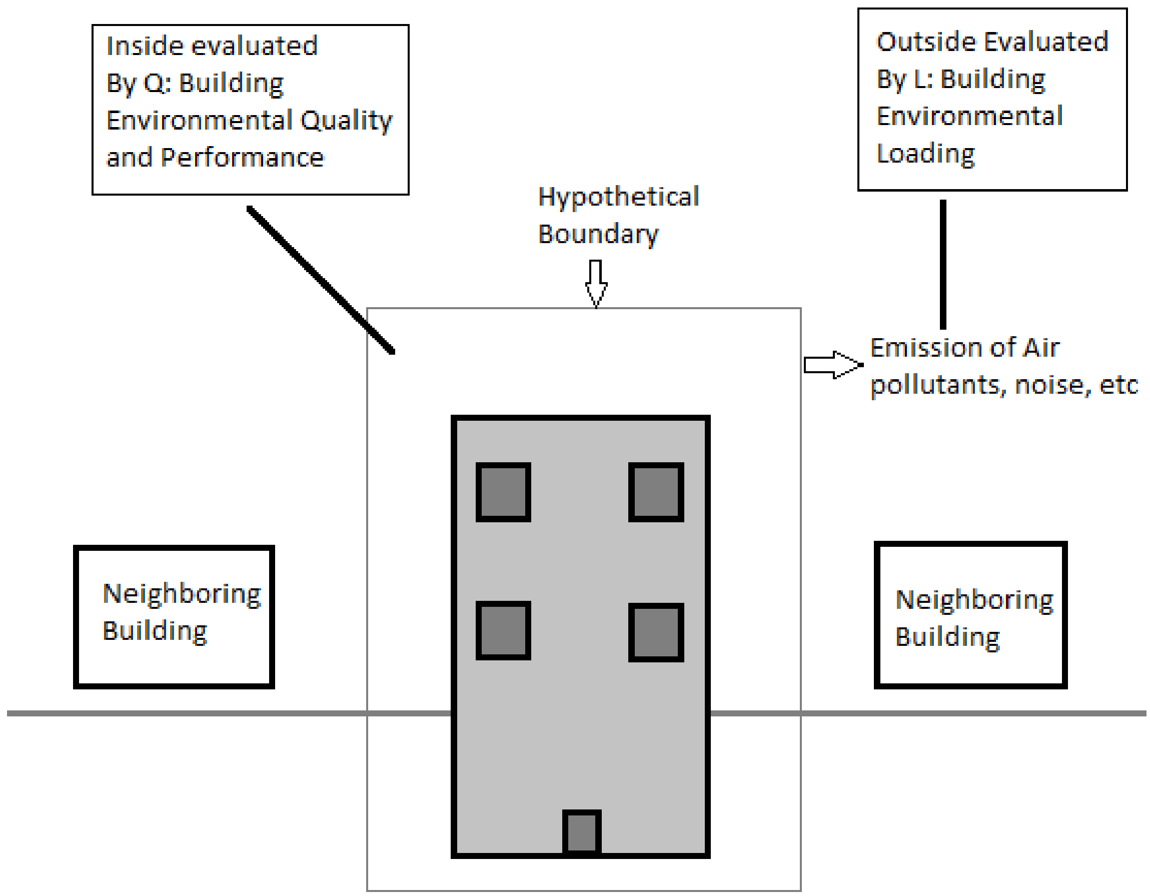

Figure 2: The Building Environmental Efficiency System (JaGBC, 2013)

Three Star was created in China in 2006. It includes two major components, the residential building evaluation system and the public building evaluation system. This standard covers six areas: land conservation, energy utilization, water utilization, material resource utilization, indoor environmental quality (IEQ), and operations management (Yang, Guo, & Li, 2011, p. 14-15). Unlike BEAM's maximum performance of a 45% reduction in annual energy use, ESGB's maximum performance is a 20% reduction in annual energy use. However, ESGB includes the use of at least 10% renewable energy (Lee, 2012, p. 238).

GREEN STAR is an assessment rating that was developed in Australia in 2003 by the Australian Green Building Council. Like BEAM, its assessment scale is based on a credit rating system, where the total number of credits earned is used to determine the level of certification (Roderick, McEwan, Wheatley, & Alonso).

2.4 Distinct Aspects of BEAM

Many different countries have specific standards for green building construction due to local environmental conditions. The properties that make a building energy efficient in a cold climate are different from those that would make a building efficient in a warm climate. BEAM Plus is tailored specifically towards Hong Kong's warm, moist, subtropical climate and its high-rise, high-density buildings.

For human comfort in Hong Kong and the surrounding region, a significant amount of air conditioning is employed. Air conditioning effectively reduces the temperature and humidity in buildings, but it also consumes a significant amount of electricity. BEAM Plus looks to combat this source of electricity use by awarding credits for use of natural ventilation to cool buildings. Effective management of sunlight entering buildings can also help to significantly reduce indoor temperature. BEAM Plus also addresses the indoor air quality issues in Hong Kong by awarding a credit if the building receives an IAQ certification from an approved source. These aspects of BEAM Plus make it a very powerful tool for green building in Hong Kong.

2.5 Other Hong Kong Building Standards

To be able to fully understand Hong Kong's current BEAM Plus standards for green buildings, one must first examine its evolution through the years and its relation to other building standards prevalent in Hong Kong. The beginning of green building standards in Hong Kong began in 1991, when the government, in an effort to combat global warming and improve local sustainability, set up an Energy Efficiency Advisory Committee (EAC). This committee advised the government on ways to improve energy conservation, and in 1994, an Energy Efficiency Office (EEO) was established under the EAC. The EEO was the first governmental body to issue codes of practice, such as the Building Energy Codes (BECs) used to specify direction for improving efficient energy practices. Under the Hong Kong government, the EEO has issued six BECs concerning energy conservation, categorized into prescriptive and performance-based approaches, which can be seen in Figure 3 below.

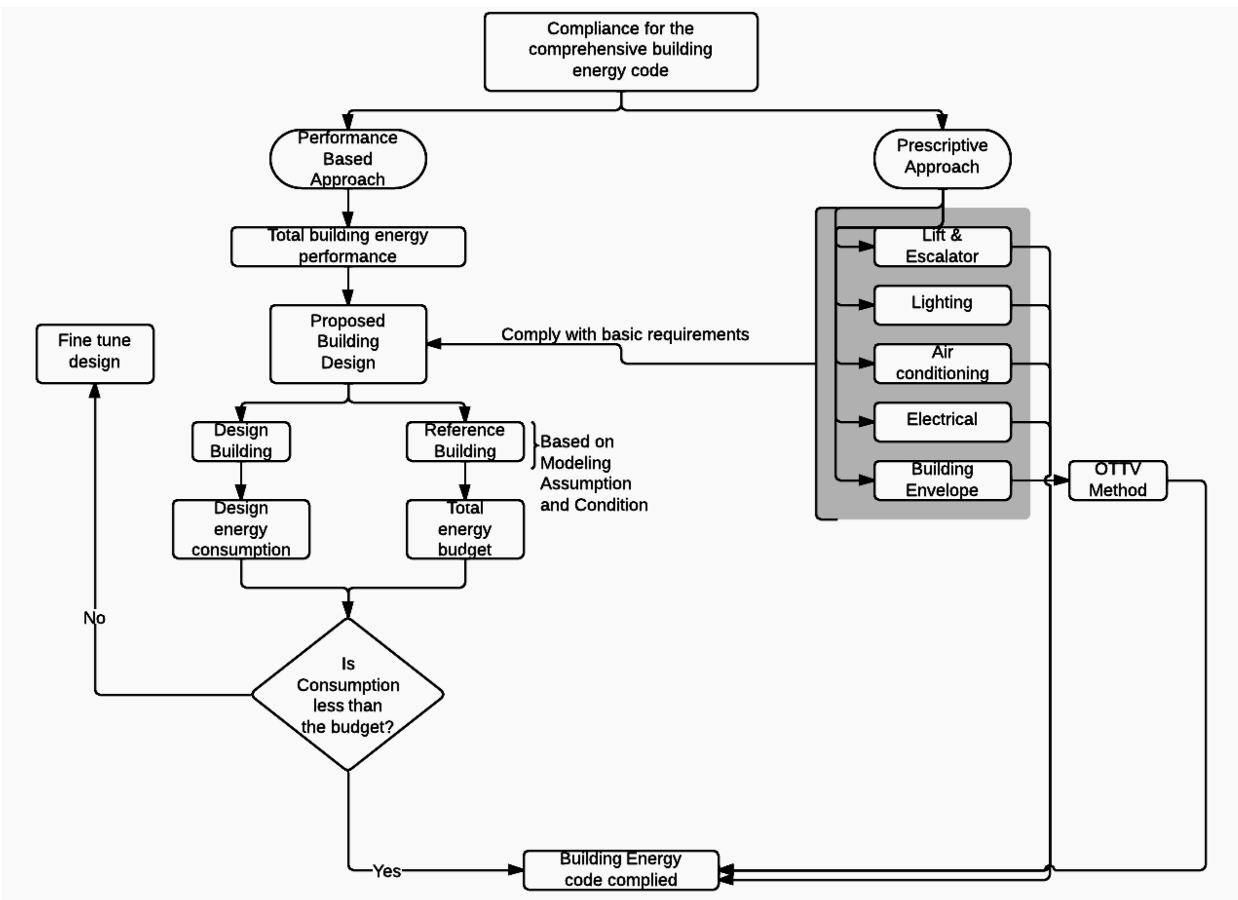

Figure 3: Building Energy Codes (Ma, 2009)

The codes under prescriptive approaches cover lift and escalator installation, lighting installation, air conditioning installation, electrical installation, and building envelope, the parts of a building that separate the indoors from the outdoors. OTTV method (Overall Thermal Transfer Value), an offshoot of building envelope, was a new approach enforced in 1995 to reduce the solar heat gain through the building envelope (Ma, 2009, p.1871). It is the only code that is mandatory for new commercial buildings in Hong Kong to follow. The other four approaches are implemented on a voluntary basis under the Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB), which was created in 1998 by the Electrical and Mechanical Services Department (EMSD). Prescriptive approaches address energy efficiency requirements using minimum design requirements, making implementing them relatively simple and easy, for they do not require major changes to existing systems. However, since they do not review the building as a whole, their impact on energy conservation is rather indirect. In contrast, performance-based codes focus on total energy consumption of a building in a systematic manner that encourages innovative design and solutions to achieve energy conservation. Unlike the prescriptive approach, these codes are generally very complicated and require extensive reworking of existing systems and specific skillsets. These codes were established in 2003 under the HKEERSB and are also voluntary for new buildings to follow (Ma, 2009, p. 1872).

In 2001, the Intelligent Building Index (IBI) was established by the Asian Institute of Intelligent Buildings to assess building intelligence. It defined nine areas of building performance, which included environmental friendliness, human comfort, safety and security measures, and health and sanitation. This index was not used like the BECs in that it did not put much focus on energy conservation, but rather focused on the areas that would directly affect the people who lived and worked in these buildings.

In 2003, the Building Quality Index was created by the Faculty of Architecture of the University of Hong Kong in order to promote building maintenance. It contains two indices, the Building Health and Hygiene Index (BHHI) and the Building Safety and Conditions Index (BSCI), both of which were created in response to the outbreak of SARS in early 2003. BHHI is composed of two main aspects, Design and Management. The Design aspect can be referred to as a building's "hardware," which includes intrinsic aspects of a building that can be hard to modify once fully completed, such as architecture (size, shape), building services (water supply, drainage), and the external environment (adjacent use, visual quality). The Management aspect is the "software," able to be changed easily, such as operations and maintenance (cleaning, pest control) and building management (organization, documentation). The BSCI uses the same two aspects as BHHI, Design and Management, but focuses on risks and condition problems.

In 2004, The Comprehensive Environmental Performance Assessment Scheme for Buildings (CEPAS) was established by the Hong Kong government under the 2001 Government Policy Objectives. This environmental performance standard for buildings sought to address typical issues, such as energy use, while also focusing on socio-economic factors such as building economics, heritage conservation, and impacts on the building's surroundings (Ho, 2005, p. 49). There are eight performance criteria in CEPAS, defined as Indoor Environmental Quality (IEQ), Building Amenities, Resource Use, Loadings, Site Amenities, Neighborhood Amenities, Site Impacts, and Neighborhood Impacts (Ho, 2005, p. 52). A matrix illustrating the performance criteria under CEPAS can be found below in Table 1.

Table 1: Performance Criteria Covered Under CEPAS (Ho, 2005)

	Building	Context
Human	IEQ Building Amenities	Site Amenities Neighborhood Amenities
Physical	Resource Use Loading	Site Impacts Neighborhood Impacts

2.6 Definition of a "Credit"

The aspects of a building that are covered under BEAM, which are site aspects (SA), material aspects (MA), energy use (EU), water use (WU), indoor environmental quality (IEQ), and innovations and additions (IA), contain a number of credits. These credits are defined as criteria that a building must satisfy to become certified. Points are awarded when defined building performance criteria are satisfied, and these individual credits are later combined to determine an overall BEAM level.

The calculation of satisfied credits for a building depends on a number of factors. In addition to the possibility of a building satisfying a credit, a building project can also choose not to submit information or apply for an exemption for a specific credit. Not submitting information is equivalent to admitting that a building cannot satisfy a certain credit. As for applying for an exemption, the BEAM standard does not apply to all buildings. For example, a credit fashioned for a residential building may be impossible for a commercial building to satisfy. There is also the matter of awarding credits to a building composed of multiple areas, such as a commercial section and a car park. The commercial section would be weighted much higher than the car park, as it would consume more resources. For instance, in a situation where the building under question is composed of a commercial area and a car park, weighted 85% and 15% in respect to overall energy use. Imagine the building achieved 12 credits for a reduction in annual energy consumption by 33% in the commercial area, while achieving nine credits for a 23% reduction in the car park. The calculation to find the total credits awarded would be as follows: (12*.85) + (9*.15)=10.2+1.35=11.55. Thus the building achieved 11.55 credits. The same formula would also apply to buildings with more than two areas. The majority of these credits are mandatory, while a few are considered "bonus" credits, which do not negatively affect the overall score if not attempted.

Not all credits carry the same weight. Each aspect is weighed in accordance with the significance of its overall impact in the building. Table 2 below shows the breakdown of the weighing of each credit aspect.

Table 2: BEAM Plus Category Ratings

Category	Weighting (%)
Site Aspects (SA)	25
Materials Aspects (MA)	8
Energy Use (EU)	35
Water Use (WU)	12
Indoor Environmental Quality (IEQ)	20
	100

Lastly, there is a minimum percentage at which a building qualifies for a certain BEAM level. For example, a building that achieves a Platinum level must satisfy 70% of SA credits, 70% of EU credits, 70% of IA credits, achieve 3 credits in IA, and have an overall achievement level of 75% across all BEAM aspects. A table of the levels and their percentages can be seen below in Table 3 (Unclassified is any level below Bronze but still achieving the BEAM prerequisites).

Table 3: BEAM Plus Minimum Requirements For Rating Categories

	Overall	SA	EU	IEQ	IA	
Platinum	75%	70%	70%	70%	3 credits	(Excellent)
Gold	65%	60%	60%	60%	2 credits	(Very Good)
Silver	55%	50%	50%	50%	1 credit	(Good)
Bronze	40%	40%	40%	40%	-	(Above Average)

2.7 Differing Adherence between BEAM Credits

A preliminary study conducted by the Hong Kong Green Building Council in July 2013 has revealed that there are ten most commonly achieved credits as well as ten least commonly achieved credits, as shown in Tables 4 and 5 below. The most commonly achieved credits are defined as credits that are frequently achieved by the projects attempting them. The least commonly achieved credits are defined as credits that are not frequently achieved by projects. The most contested credits are credits that buildings attempt but are denied for some specified reason.

Table 4: Top 10 Highly Achieved Credits

Credit description	% of projects achieving
IA3 – BEAM Professional	95
EU10 (Normal) – Commissioning specification, plan, process and report	84
IEQ6 – Meeting IAQ Good Class for CO, NO_2, O_3, and PM_{10}	84
SA10 – Environmental Management Plan	82
WU6 – Reduction in annual sewage volume by at least 20%	82
IEQ7 – Meeting IAQ Good Class for VOC, formaldehyde and radon	81
EU12 – Installation of adequate metering and instruments	79
SA4 (Normal) – Achieve at least 50% of relevant sub-items of Urban Design Guidelines	79
IEQ2 –Plumbing and drainage system design to reduce transmission of diseases	75
IEQ1 – Scoring at least 75% of applicable security measures	75

Table 5: Top 10 Least Achieved Credits

Credit description	% of projects achieving
MA5 – At least 2.5% of building materials used is rapidly renewable	0
SA1 – Conduct site contamination assessment and implement measures for rehabilitation, and/or proper preparation of sites adjacent to landfill	0
IEQ19 (Bonus) – Impact noise isolation between floors of residential building meets IIC52	0
WU4 (Normal) – Apply both rainwater harvesting and grey water recycling, each leading to a fresh water saving of at least 5%	0
SA8 – Wind amplification, elevated temperatures and AVA study	2
EU6 – Renewable energy (at least 2.5% of building energy consumption or 100% of building footprint)	4
MA3 – Apply prefabrication to at least 40% of listed building elements	5
MA7 – Use of recycled materials for at least 10% of materials in all three categories: external works, structure and interior components	5
WU2 – Install devices to monitor water leakage from fresh water distribution systems	7
SA7 – Planting to at least 40% of site area and using pervious materials for at least half of the hard landscaped area	7

Table 6: Top 10 Most Contested Credits

Contested Credits	No. of cases (out of 57)
WU2 – Install devices to monitor water leakage from fresh water distribution systems	16
IA2 – Performance enhancements	13
SA8b – Elevated temperatures (providing shade on at least half of non-roof impervious surfaces using light-coloured high-albedo materials; and provide roof material that meets solar reflectance index of 78 or vegetation roof covering at least half of the total roof area)	9
SA4 (bonus credit) – Achieving 100% of relevant sub-items of Urban Design Guidelines	8
MA4b – Flexible engineering services	8
EU9 – Energy efficient appliances	8
EU13 – Energy efficient building layout	8
SA8a – Wind amplification (demonstrate no pedestrian areas will be subject to excessive wind velocities)	7
EU2 – Peak electricity demand reduction	6
EU7 – Comply with recommended installation requirements for AC units	5

As mentioned previously in the introduction, a problem with BEAM is “green washing”. The top 10 highly achieved credits show a strong possibility of being a victim of this phenomenon. This report will explain solutions to this problem, as well as uncover the reasons why performance of a certain credit falls into any of these three categories and recommend changes to improve the rating tool.

3. Methodology

To successfully analyze and improve the BEAM Plus scheme, the team needed an efficient plan to gather and organize the necessary data. To ensure the success of the project, data gathering was divided into three distinct elements: an analysis of reports on existing BEAM certified buildings, field surveys of a number of these buildings, and a focus group discussion with BEAM Plus practitioners. All of these elements were crucial to improving the BEAM Plus scheme in certain ways. For example, the analysis of BEAM Plus certification reports was necessary for both determining which credits were the least successful and directing the other phases of research based on our findings. The focus group was critical because the BEAM Plus practitioners provided invaluable firsthand insight on the weaknesses and strengths of different BEAM Plus credits. The field surveys were also important because they enabled the team to observe the success or failure of green technologies and methods after their initial implementation. Through these tasks, the project team was able to make a series of recommendations to improve the BEAM Plus rating system.

3.1 Data Analysis

The first phase of the project consisted of augmenting a data set of the credit achievement for all BEAM Plus buildings completed previously by the HKGBC. The data was extracted from reports that each of the 110 BEAM Plus buildings submitted to get their certification. Contained in each of the reports was a summary of the completion for each credit. The completion level (fully achieved, partially achieved, contested, not submitted, or not applicable) of each credit was recorded for every building. In addition, the number of credits achieved for each credit requirement was recorded so a more accurate data set could be built. The recorded data was then entered into Excel sheets to obtain a visual representation of the credit requirements, such as those that were not attempted or were contested by the buildings (credit was submitted for completion but was denied). After this task, the building reports were examined in-depth to get more specific numbers on topics such as annual water savings, percentage of green site area (area with vegetation), and renewable energy sources. The implementation of specific technologies, such as dual flush water closets and automatically dimming lights, was recorded at this time. In the process of analyzing the building reports, the team also noted the reasons that the contested credits were not achieved. This list of reasons was crucial for the improvement of BEAM Plus because it highlighted exactly why certain credit requirements were being failed. From these findings, the team was able to make recommendations on how to improve various credit requirements.

achieved, partially achieved, contested to the success of each subsequent part of the methodology. For example, the dataset was used to help create the most precise and relevant questions for the focus group. group. corded so a more determining which questions to ask during site visits because it revealed to the team what each building did and did not utilize in terms of green technologies. Overall, the expansion of the dataset on BEAM Plus credits provided a strong foundation on which the team could build the other aspects of the methodology.

3.2 Focus Group Discussion

The focus group was the single most important event that occurred while the project team was in Hong Kong. To reiterate, one of the main objectives of this project was to increase the achievement of the credits that have the lowest overall achievement. While the data analysis was critical in establishing which credits have the lowest adherence, the focus group gave insight into the exact reasons why. The focus group consisted of eight BEAM Plus practitioners, defined as people who assist in getting a building BEAM Plus certified. They possessed unique insight into why certain credits were not attempted and how to improve them. Both written notes and electronic recordings were taken of the focus group so that the greatest accuracy could be used when compiling all the knowledge that was gained. The event lasted about one hour and forty-five minutes and consisted of a brief presentation from the project team, after which followed a series of questions.

The first phase of preparation for the focus group was the formulation of the questions. The exact phrasing of each question was carefully considered to avoid making the questions sound negative or accusatory. For example, the word “why” was avoided because it can give a sense of being accused. Another consideration made while designing the questions was to be sure that the credit being asked about was clear and easily understood. In order to do this, each question contained a short summary of the credit requirement that was being asked about. There are numerous BEAM Plus credits, some of which have multiple sub-categories, so clarity as to which was being asked about was paramount to getting accurate and valuable responses. The team ended up preparing eight lines of questions, each line focusing on the strengths or weaknesses of a certain credit. The full list of questions can be found in Appendix C.

After the team was confident with the questions for the focus group, which contained edits and input from the sponsor, they sent out a short briefing to the participants. The briefing contained a number of documents, including a summary of the data analysis that the team had already completed and the list of questions to be asked. These were sent one week in advance of the focus group to enable the BEAM Plus practitioners to think about their answers beforehand or review anything that they might need to know in order to provide a more detailed answer during the event.

During the focus group, each member of the team was responsible for a certain role. One member was in charge of the logistical aspects of the meeting, such as making sure that all participants knew where to go, handing out the team's business cards, and procuring necessary snacks and beverages. Two team members were to take notes and be sure that the recording of data was functioning properly. Lastly, one was to ask the questions and guide the discussion.

With the data gathered from the focus group, the team gained a much better understanding of the BEAM Plus system and a clear idea on what changes were needed to improve it. The information on the BEAM Plus credits that was gained from a primary source, especially those who work with the credits on a daily basis, became the cornerstone of our recommendations to improve the BEAM Plus scheme overall.

3.3 Field Survey

The team also conducted field surveys of 5 BEAM Plus certified buildings. These surveys were performed to assess the continuing use of technologies and methods for which the building received BEAM Plus credits. This was an important study to conduct because it enabled the team to gather data on buildings that was not evident, revealed in the reports, or otherwise available. The field survey consisted of three separate elements: a survey for building occupants to complete, an interview with building and maintenance managers, and an observation of building equipment. Through these three activities the team was able to determine if buildings were continuing to act in accordance with their BEAM Plus certification and determine any longevity problems that green technologies were having after their initial implementation.

The first part of the site survey was the survey of building occupants. This survey was designed with multiple goals in mind: first to determine the opinions of those occupying BEAM Plus buildings as a whole, second to get feedback from them on specific green technologies implemented in their building, and third to learn if there was anything that the building occupants wanted to add to BEAM Plus. The data collected about general BEAM Plus awareness was useful for determining how a BEAM Plus rating affected the desirability of a building. The occupants of a building were also useful in providing a unique perspective on the green technologies within the building. They enabled the team to learn if a certain technology caused significant discomfort, such as if open windows for natural ventilation increased the noise in the building to an unacceptable level. The occupants were critical in establishing if green technologies were performing as well as they should have been. For example, if a building had low flow faucets, the rate of water flow might not be high enough, and the time that the faucet needed to be on increased to a point at which the advantages from the low flow faucet would be negated. There are many other green technologies and techniques that could have similar issues, and through a survey of the occupants the group gained a sense for which technologies significantly inconvenienced occupants or were not actually increasing efficiency. The full list of questions for building occupants can be found in Appendix D. In all, occupants had a valuable perspective and provided insight into how successful green technologies are and how they affect the people in BEAM Plus buildings.

The team also observed green technologies in use and noted whether or not the technologies were being used as planned. In order to evaluate the buildings successfully, the team created a list of observable technologies that each building had received credit for. During the site visits, the team would be sure that every item on their list was observed and that notes had been taken regarding their use and effectiveness. These observations were important for the team because it was a firsthand method of measuring the implementation of various green technologies, as opposed to being a second or third hand source through other people (which can introduce error into data collection). One such observed technology was the use of daylight sensors in buildings, which would automatically turn lights on or off based on the amount of light in the room. The team looked for their use on certain site visits and found them not to be in use. The team also discovered that some BEAM Plus building occupants found the automatic light switches to be an annoyance, so they were disabled. A sample site survey checklist can be found in Appendix E. The team's observations of each site were useful, but in order to gain a more in-depth picture of a building, other methods, such as interviews, were required.

The final and most informative part of the site visits consisted of interviews with both the building management and maintenance personnel. These interviews were the most efficient method for the team to quickly gain knowledge about the actual performance of BEAM Plus buildings after they had been built and operated for a period of time. The building managers had valuable perspectives on many aspects that the team otherwise would not have been able to see or quantify, such as the cost effectiveness of many of the energy and water conservation technologies. Even more valuable were the interviews with maintenance personnel. The maintenance staff had a unique and close relationship with the green technologies implemented in a building. One example of the knowledge that the team was able to obtain from the maintenance manager of the building was if there were any problems with the green roofing or plantings at a site. The team could not have easily been able to tell if all the plantings that were in the assessment report were in place, but through talking with the maintenance staff and management of that building such knowledge could easily be obtained. The staff offered useful insight into not only the efficiency of the green technologies implemented in their building, but also the reliability and practicality of these systems. The list of questions for the building management and maintenance staff can be found in Appendix F.

Over the eight weeks in Hong Kong, the team was hard at work in conducting frequent site visits and data analysis. The data analysis provided a strong foundation on which the questions for the focus group and site surveys could be built, which in turn enabled the team to generate strong recommendations to improve the BEAM scheme.

4. Results

Through the data analysis outlined in the methodology, the team was able to create new versions of the tables that were presented in the background. To obtain the necessary data, the team studied a total of 110 BEAM Plus building assessment reports. Preliminary data that was compiled by interns before the start of the project was updated at this time. In addition, the data analysis was broadened in scope, with credits broken up into their respective sub-credits (a, b, c, etc.). Before this change, it was difficult to find which specific sub-credit(s) within a credit was/were the problem. Thus the initial tables mentioned previously only contained data on credits as a whole. This was misleading, as some sub-credits enjoyed adequate adherence and did not need to be changed, while others in the same credit had very low adherence and needed to be addressed. The full graph of credit achievement and number of times a credit was contested (both in order of achievement and in order that the credits appear in the BEAM Plus Guidebook) can be seen in appendices G-J. This new data set is the most current data available to the Hong Kong Green Building Council that address the adherence of specific credits. The team hopes that this data set can be expanded by future WPI IQP projects.

Through completing the tasks outlined in the preceding methodology, the team was able to create recommendations to improve the BEAM Plus scheme. For convenience, Table 4 (the top 10 achieved credits), Table 5 (top 10 least achieved credits), and Table 6 (top 10 most contested credits) have been duplicated here alongside their updated counter parts, Table 7, Table 8, and Table 9 respectively. These specific credit areas were where the team focused for making recommendations. A thorough explanation of each credit requirement in these tables will be given, followed by suggested improvements to each one and the justification for the improvements.

Table 7: Top 10 Highly Achieved Credits

Credit description	% of projects achieving
IA3 – BEAM Professional	95
EU10 (Normal) – Commissioning specification, plan, process and report	84
IEQ6 – Meeting IAQ Good Class for CO, NO_2, O_3, and PM_{10}	84
SA10 – Environmental Management Plan	82
WU6 – Reduction in annual sewage volume by at least 20%	82
IEQ7 – Meeting IAQ Good Class for VOC, formaldehyde and radon	81
EU12 – Installation of adequate metering and instruments	79
SA4 (Normal) – Achieve at least 50% of relevant sub-items of Urban Design Guidelines	79
IEQ2 –Plumbing and drainage system design to reduce transmission of diseases	75
IEQ1 – Scoring at least 75% of applicable security measures	75

Table 8: Top 10 Most Achieved Credits After Data Analysis

Top 10 Most Achieved Credits	% of projects achieving
IA3 BEAM Pro	93
EU11a O&M - O & M Manual	86
EU10c T &C - Commissioning	86
EU10d T &C - Commissioning Reports	86
EU11b O&M - Energy Management Manual	86
EU10a T & C - Commissioning Specifications	85
SA10 EM Plan	80
EU10b T & C - Commissioning Plan	80
MA8a Ozone Depleting Substances - Refrigerants	79
IEQ6 Outdoor Sources of Air Pollution	79

Table 9: Top 10 Least Achieved Credits

Credit description	% of projects achieving
MA5 – At least 2.5% of building materials used is rapidly renewable	0
SA1 – Conduct site contamination assessment and implement measures for rehabilitation, and/or proper preparation of sites adjacent to landfill	0
IEQ19 (Bonus) – Impact noise isolation between floors of residential building meets IIC52	0
WU4 (Normal) – Apply both rainwater harvesting and grey water recycling, each leading to a fresh water saving of at least 5%	0
SA8 – Wind amplification, elevated temperatures and AVA study	2
EU6 – Renewable energy (at least 2.5% of building energy consumption or 100% of building footprint)	4
MA3 – Apply prefabrication to at least 40% of listed building elements	5
MA7 – Use of recycled materials for at least 10% of materials in all three categories: external works, structure and interior components	5
WU2 – Install devices to monitor water leakage from fresh water distribution systems	7
SA7 – Planting to at least 40% of site area and using pervious materials for at least half of the hard landscaped area	7

Table 10: Top 10 Least Achieved Credits After Data Analysis

Top 10 Least Achieved Credits	% of projects achieving
IA1 – Innovative Techniques	0
MA5 – Rapid Renewable Materials	0
SA1 – Contaminated Land	0
IA2 – Performance enhancements	0
WU4b – Water recycling – Recycled Water	2
SA8b Microclimate - Elevated Temperatures	3
IEQ19 Noise isolation between rooms (bonus credit)	3
WU2 Leak monitor for exposed pipes	4
MA7c Recycled Materials - Interior Building Component	4
EU6 Renewable energy	5

Table 11: Top 10 Most Contested Credits

Contested Credits	No. of cases (out of 57)
WU2 – Install devices to monitor water leakage from fresh water distribution systems	16
IA2 – Performance enhancements	13
SA8b – Elevated temperatures (providing shade on at least half of non-roof impervious surfaces using light-coloured high-albedo materials; and provide roof material that meets solar reflectance index of 78 or vegetation roof covering at least half of the total roof area)	9
SA4 (bonus credit) – Achieving 100% of relevant sub-items of Urban Design Guidelines	8
MA4b – Flexible engineering services	8
EU9 – Energy efficient appliances	8
EU13 – Energy efficient building layout	8
SA8a – Wind amplification (demonstrate no pedestrian areas will be subject to excessive wind velocities)	7
EU2 – Peak electricity demand reduction	6
EU7 – Comply with recommended installation requirements for AC units	5

Table 12: Top 10 Most Contested Credits After Data Analysis

Top 10 Contested Credits	No. of Cases (out of 110)
IA2 – Performance enhancements	20
WU2 – Install devices to monitor water leakage from fresh water distribution systems	20
EU11c – Operator training and operation and maintenance facilities	17
SA8b – Elevated temperatures	15
EU13 – Energy efficient building layout	14
EU9 – Energy efficient appliances	14
MA4b – Flexible engineering services	14
MA4a – Spatial adaptability	13
EU2 – Estimated maximum electricity demand for commercial buildings	12
SA4(Bonus) – Site design appraisal	11

5. Recommendations

For this project the team focused on a few key areas of BEAM Plus for improvement. The first area was those credits that were very frequently achieved by applicants; these were selected for review because they were viewed as too easy to satisfy. These credits were altered so that they could be more beneficial for the environment or be worth fewer points, so that buildings would be forced to seek points elsewhere. The second set of credits that was reviewed by the team was the contested credits. These are credits that buildings attempted to gain credit for but were denied. These credits were part of this project because there were frequently misinterpretations of the BEAM Plus Guidebook by the building designers and a change could be made to prevent this. The next set of credits that was looked at was the credits that had a low achievement rate. These are a problem because very few buildings are satisfying these credits and they are doing very little for the environment. The last set of credits in BEAM Plus that the team looked at in this study was bonus credits that had high achievement. A bonus credit should be difficult because they cannot hurt a building's score. They only contribute to the score, and if they are frequently achieved it means that they are too easy to warrant being a bonus credit. However, the team did not limit its recommendations to just altering existing credits.

During their time in Hong Kong the team also looked into other ways that the BEAM Plus system could be improved. The team recommends adding a few credits to BEAM Plus that would help to improve the "human nature" of BEAM Plus buildings and increase the cultural consciousness of BEAM Plus. The team also recommended a few changes to the BEAM Plus scoring system to help improve achievement in all BEAM Plus categories.

5.1 Highly Achieved Credits

High achievement credits were included in this study because they are too easily achieved and should be made more rigorous. The BEAM Plus scheme exists to encourage green building development, and if credits are not rigorous enough then the scheme is not doing all that it possibly can for the environment. In addition, these credits are part of a problem called "green washing", which is when a building achieves the easiest credits, not necessarily the ones most beneficial for the environment. Easily achieved credits are also a problem because they are a way for a building to get many credits with relatively little effort.

This project focused on the following highest achieving credits: IA3, EU10a-d, EU11a and b, SA4 (normal), SA10-13, and MA8a and b. All of these credits have achievement rates higher than 74%, with most of them being above 80%. If the projects that achieve just one less credits are included in the data set, most of these credits are above 90% achievement. This indicated to the team that they were too easily achieved and should be made more rigorous or worth fewer points.

Since the credits that fell under the highest achieving category were those that were required for a building to become certified, it was not feasible to increase their difficulty. Considering this, the team decided that the most effective way to increase their rigorousness was to reduce the number of points that these credits are worth, in turn encouraging projects to seek credits elsewhere. This was done by combining different items in sub-credits and even different credits into one credit worth fewer points, maintaining all of the original environmental benefits of the various components.

5.1.1 IA3: BEAM Professional

Credit Description: "At least 1 key member of the Project Team shall be a certified BEAM Professional."

Problems: This credit is very frequently achieved. The only projects that do not achieve this credit do not achieve any other credits.

Proposed Solution: Make this credit a prerequisite.

Justification for Solution: Almost all (92.6%) of BEAM Plus buildings achieved this credit. The only projects that did not achieve this credit did not achieve any credits at all. A BEAM professional on the project team is necessary to any project that is serious about getting BEAM certified at any level above unclassified. Because this credit is contained in the Innovations and Additions area, it is almost three times more heavily weighted than the next highest category of credits. This should be avoided so projects must achieve more environmentally beneficial credits to get the same level of certification. This credit would fit well as a prerequisite because it is essential to achieving BEAM certification and is currently much more heavily weighted than most environmentally oriented credits.

5.1.2 EU10a-d: Testing and Commissioning

Credit Description (a): "1 credit for provision of appropriate specifications and/or cost provisions in contract documents detailing the commissioning requirements for all systems and equipment that impact on energy use and indoor environmental quality."

Credit Description (b): "1 credit for the appointment of a commissioning authority and provision of a detailed commissioning plan that embraces all specified commissioning work."

Credit Description (c): "1 credit for ensuring full and complete commissioning of all systems, equipment and components that impact on energy use and indoor environmental quality."

Credit Description (d): "1 credit for providing fully detailed commissioning reports for all systems, equipment and components that impact on energy use and indoor environmental quality."

Problems: Very frequently achieved and worth four heavily weighted (35%) credits.

Proposed Solution: Combine credits a-d into 1 credit requirement, EU10a, consisting of 4 elements derived from the current EU10a-d. One credit would be awarded for 50% satisfaction of the items (such as satisfying b and c) and 2 credits for 100% satisfaction.

Justification for Solution: EU10a-d is currently worth four heavily weighted credits and all subsections have achievement of over 80%. This means that four high value credits are easily achieved by many projects. This shifts the focus off of other environmentally important credits that are not so easily achieved. By reducing the number of credits available for EU10, the effective weighting is reduced, which will shift the focus to other environmentally relevant credits. In addition, the sub-credits are similar enough that they can reasonably be combined.

5.1.3 EU11a-b: Operations and Management

Credit Description (a): "1 credit for providing a fully documented operations and maintenance manual to the minimum specified."

Credit Description (b): "1 credit for providing fully documented instructions that enable systems to operate at a high level of energy efficiency."

Problems: Very frequently achieved and worth two heavily weighted (35%) credits.

Proposed Solution: Combine a-b into 1 credit, EU11a, and change EU11c to EU11b. Make the new EU11a worth 1 credit.

Justification for Solution: EU11a and b both have an achievement rate over 80% and are each worth one heavily weighted (35%) credit. This means that two high value credits are achieved by many projects. By combining the two subsections into one credit requirement worth one credit they become worth only half of the points that they were previously. This will cause projects to look to achieve other credits to attain the same score. The sub-credits are similar enough that they can reasonably be combined.

5.1.4 SA4: Site Design Appraisal (normal)

Credit Description: "1 credit for site design appraisal report demonstrating a proactive approach to achieve greater integration of site planning and design issues, and at least 50% of relevant sub-items of the Urban Design Guidelines in the Hong Kong Planning Standards and Guidelines are achieved."

Problems: This credit is too easily achieved by projects.

Proposed Fixes: Increase the required achievement percentage of the Urban Design Guidelines to 75%.

Justification for Solution: The credit currently has 77% achievement across all BEAM Plus buildings and requires that 50% of the 22 Urban Design Guidelines are satisfied, which translates to the fulfillment of 11 of these guidelines. An increase to 75% would translate to 17 of the Urban Design Guidelines being met. This is a reasonable change as at least 30% of projects already satisfy more than 17 of the guidelines. By increasing the number of Urban Design Guidelines that a project must achieve to gain credit, BEAM Plus will further improve the quality of the built environment in Hong Kong. All in all this is an achievable percentage increase for many buildings.

5.1.5 SA10-13: Environmental Management Plan, Air Pollution Plan, Noise Plan, Water Pollution Plan

SA10

Credit Description: “1 credit if an Environmental Management Plan including Environmental Monitoring and Auditing has been implemented.”

SA11

Credit Description: “1 credit for applying adequate mitigation measures for dust and air emissions during the construction as recommended by the Environmental Protection Department; and demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.”

SA12

Credit Description: “1 credit for providing adequate mitigation measures for construction noise for all Noise Sensitive Receivers.”

SA13

Credit Descriptions: “1 credit for undertaking adequate measures to reduce water pollution during construction.”

Problem: All four credits have very high (>74%) achievement.

Proposed Solution: Combine all four separate credits into one credit with four items, worth a total of two points. The items will be taken in their entirety from SA10-13. One point will be awarded for satisfying 50% of the items, while two points will be awarded for satisfying 100% of them.

Justification for Solution: Buildings frequently achieve either all of these credits or none of them. Therefore combining them into one credit worth half the total points is a reasonable change to make. All of these credits deal with having an environmentally friendly and community conscious construction site. By combining these credits and halving their total worth, projects will need to achieve other credit requirements to gain the same rating. The team also believes that this will encourage the projects that achieve only some of these credits to seek to satisfy the rest of them.

5.1.6 MA8a and b: Ozone Depleting Substances

MA8a

Credit Description: "1 credit for the use of refrigerants with a value less than or equal to the threshold of the combined contribution to ozone depletion and global warming potentials using the specified equation."

$$LCGWP + LCODP \times 10^5 \leq 775$$

$LCGWP = [GWPr \times (Lr \times Life + Mr) \times Rc] / Life$

$LCODP = [ODPr \times (Lr \times Life + Mr) \times Rc] / Life$

LCGWP = Lifecycle Global Warming Potential (kg CO_2 /kw -Yr)

LCODP = Lifecycle Ozone Depletion Potential (kg CFC 11/kw-Yr)

GWPr = Global Warming Potential of Refrigerant (0 to 12,000 kg CO_2 /kg r)

ODPr = Ozone Depletion Potential of Refrigerant (0 to 0.2 kg CFC 11 /kg r)

Lr = Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)

Mr = End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)

Rc = Refrigerant Charge (0.2 to 2.3 kg of refrigerant per kW of gross ARI rated cooling capacity)

Life = Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

MA8b

Credit Description: "1 credit for the use of products in the building fabric and services that avoids the use of ozone depleting substances in their manufacture, composition or use."

Problems: The refrigerant calculation is too easily achieved.

Proposed Solution: Combine MA8a-b into one credit and make the equation in part a more difficult. Specifically decrease the constant at the end, which requires researching the latest refrigerants, and is outside the scope of this project.

Justification for Solution: The team is hopeful that combining these two credits into one would encourage buildings that failed either of them to satisfy them both. These credits both deal with ozone depleting aspects of buildings, so combining them is justified. Increasing the difficulty of the equation in MA8a will cause buildings to be more environmentally conscious. Overall, this credit has a sufficiently high achievement rate as to warrant an increase in difficulty.

5.2 Contested Credits

The most contested credits were examined by this project because they are credits that are attempted but, for some reason, are not successful. This is a problem because it means that the credit requirements contained in the BEAM Plus Guidebook are not clear.

The credits that fall into the contested category are EU11c, EU9, MA4a, MA4b, EU2, and SA4. All of these credits were contested by more than 10 building projects. The goal of the team was to focus on the most contested credits, which were those with distinctly high contested rates.

These credits were generally addressed by increasing the clarity of the BEAM Plus Guidebook. This was achieved in three ways. First, words and small phrases were added to credit descriptions to increase their clarity, such as the addition of the word "all", or changing "or" to "and". Second, supplemental definitions of potentially vague words in the BEAM Plus Guidebook were added so that confusion would be reduced. Lastly, more specific requirements were added to credits so that the building designers would know exactly what was required of them to achieve a credit.

5.2.1 EU11c: Operations and Management (O&M) Operator Training and O&M Facilities

Credit Description: "1 credit for providing training for operations and maintenance staff to the minimum specified; and demonstrating that adequate maintenance facilities are provided for operations and maintenance work."

Problems: Applicants are claiming inappropriate spaces to use for maintenance, such as pump rooms and watchman's quarters. This credit is unclear on which specific locations are appropriate for maintenance.

Proposed Solution: Specify that the maintenance room(s) is a dedicated workspace used solely for maintenance work.

Justification for Solution: Many applicants are claiming that washrooms and pump rooms are maintenance space. This is not the intent of the credit. This credit is intended to ensure that adequate facilities for maintenance staff are provided to perform important tasks, such as fixing building equipment and storing tools. By rewording this credit to specify that this space is only for maintenance work, the team believes that the rate of contention for this credit will decrease.

5.2.2 EU9: Energy Efficient Appliances

Credit Description:

- "1 credit when 60% of total rated power of appliances and equipment are certified energy efficient products."
- "2 credits when 80% of total rated power of appliances and equipment are certified energy efficient products."

Problems: Applicants are not counting all of their appliances and equipment in the calculation for the total rated power of their building. There is also a problem of not providing any calculations or providing incorrect calculations in support of the credit.

Proposed Solution: Change the phrase "appliances and equipment" to "all appliances and equipment" in the credit description. State that the applicant must provide sufficient evidence that the calculation scheme used is equivalent to the schemes stated in the BEAM guidebook.

Justification for Solution: The addition of the word "all" will help to clarify that the credit requirement applies to every appliance and piece of equipment in the building. In addition, there were a number of buildings that claimed the appliances were certified under the China Energy Label, but this scheme is not viewed as equivalent to those that are listed in the BEAM Plus Guidebook. In addition, no evidence was provided by applicants to prove that the China Energy Label is a rigorous enough to be considered by BEAM Plus. By making the suggested changes, it is the opinion of the team that the clarity of the credit will increase and the frequency with which it is contested will decrease.

5.2.3 MA4a: Adaptability of Deconstruction – Spatial Adaptability

Credit Description: "1 credit for designs providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated."

Problems: The focus group attendees voiced the opinion that this credit may not be applicable for residential buildings.

Proposed Solution: Reduce the percentage of required checklist items for residential buildings to 25% from its current 50%. Modify the following item descriptions within the credit: "Spaces designed for a loose fit rather than tight fit," "Inclusion of multifunctional spaces," and "Use of interior partitions that are demountable, reusable and recyclable, etc."

Justification for Solution: The focus group expressed the opinion that this credit was not applicable for residential buildings because, compared to commercial buildings, spaces in them are generally smaller and used for living. his credit was not applicable for residential buildings because, compared to commercial buildings, spaces in theecyclable, etc." buildings had to achieve fewer adaptability items than other building types. The team believes that while the percentage is lower for residential buildings, it should be further reduced to more accurately reflect the capabilities of that building type. Items #2 (Loose Fit), #3 (Multifunctional Spaces), and #9 (use of partitions) are also frequently submitted for this credit but are denied. For this reason the clarity of those sub items has been changed.

5.2.4 MA4b: Adaptability of Deconstruction his crble Engineering Services

Credit Description: “1 credit for flexible design of services that can adapt to changes of layout and use.”

Problems: This credit has two problems. The first one is that flexible features in many buildings are only in select areas, failing to span the entire development. The second problem is there is a lack of explanation of how the relocation of flexible buildings elements can be done.

Proposed Fixes: Specify that flexible systems must span the entire development area and explain how the relocation of flexible building elements can be achieved.

Justification for Solution: By adding these phrases to the BEAM guidebook, the team believes that the credit requirements will more accurately reflect the intention of this credit and will more clearly state what needs to be provided by the applicant. Therefore the applicants will be able to more easily achieve this credit.

5.2.5 EU2: Reduce Peak Demand

Credit Description: "(a) Commercial and Hotel Buildings: 1 to 3 credits for a reduction in the peak electricity demand by 15%, 23%, and 30% respectively."

"(b) Educational and Residential Buildings: 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12%, and 15% respectively."

"(c) Other Building Types: 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12%, and 15% respectively."

Problems: Building projects that contain multiple areas, such as separate commercial and residential sections, are not properly counting the different areas when considering energy use.

Proposed Solution: Reword the credit to state the following: "If a building contains a combination of sections, such as residential and commercial areas, each area should be assessed under its specific credit area (a, b, or c). The scores of each area shall be appropriately weighted using the floor area of each section and the overall building shall be evaluated based on the combination of the weighted scores."

Justification for Solution: A number of the failed cases for this credit mentioned that only one area of the building was evaluated. The addition of this passage will clarify how to address buildings with multiple areas.

5.2.6 SA4: Site Design Appraisal (bonus)

Credit Description: "1 bonus credit for 100% of relevant sub-items of the Urban Design Guidelines are achieved."

Problems: The Urban Design Guidelines are quite comprehensive, making it difficult to satisfy it 100%. Specifically, the "view corridors" item is frequently unsatisfactory and is not clearly worded in the Urban Design Guidelines.

Proposed Solution: The Urban Design Guidelines are generally well stated and provide valuable guidance to building design specific to Hong Kong. Unfortunately they do not fall under the jurisdiction of BEAM and cannot be changed. However, the team would like to add in the following definition of "view corridors" to the BEAM Plus guidebook: "attractive views of notable landmarks, such as oceans, mountains, and other natural and man-made structures."

Justification for Solution: The majority of buildings fail the credit because they are not in compliance with maintaining view corridors. By providing a clear definition of a view corridor, the team believes that more projects will properly maintain them and the credit will be less frequently contested.

5.3 Credits that are Both Highly Contested and Infrequently Achieved

Credits that are both highly contested and infrequently achieved are attempted by some buildings, but they do not fulfill the credit in the eyes of BEAM Plus. They are also not frequently attempted both because of a lack of clarity in the BEAM Plus Guidebook and that they are unrealistic for buildings to achieve.

The credits that fall into this category are WU2, EU13, and SA8b. All of these credits were contested by more than 10 building projects and have an achievement rate of under 5%. The team chose these thresholds because after them there was a significant change in the numbers of buildings contesting and the percentage of buildings achieving.

These credits were generally addressed by both increasing the clarity of the BEAM Plus Guidebook and making the credits more attainable for buildings. This was achieved in primarily two ways. First, adding definitions or phrases, such as “water leakage monitoring”, to the guidebook to enhance clarity. Second, reducing the requirements of certain credits so that they more accurately reflect what buildings are capable of in Hong Kong. With these changes it is the belief of the team that the achievement rate will increase and the number of projects contesting these credits will decrease.

5.3.1 WU2: Leak Monitoring For Exposed Pipes

Credit Description: "1 credit for installation of devices to monitor water leakage from the fresh water distribution systems without embedded plumbing pipework."

Problems: The main reason of denial for this credit is that the covered area under leakage monitoring is not sufficient. In addition, the applicants do not understand the expectations of BEAM Plus as to what constitutes water leakage monitoring across the entire building, i.e. detecting that there is a leak "somewhere" or being able to pinpoint the leak. It is impractical to apply water leakage monitoring system to some types of buildings (i.e. residential building). Focus group respondents cite a high cost for installing the monitoring system in all pipework.

Proposed Solution: Return the wording of the credit to the way it appeared in BEAM version 1.1, and add one bonus credit (1) for the section stating "without embedded plumbing pipework". In addition, add specifics about which pipes need to be monitored and where.

Justification for Solution: The focus group participants informed the team that this credit was frequently achieved in BEAM Plus version 1.1. The only change in the wording of the credit between versions 1.1 and 1.2 was the addition of the phrase "without embedded plumbing pipework". Thus the changing of that phrase to its own separate bonus sub-credit would help to restore the achievement of this credit. The team believes that the normal credit will also become more rigorous than it was in BEAM version 1.1 by adding specifics on what is meant by water leakage monitoring. By increasing the clarity of the credit requirement, the team believes that the number of projects that attempt and achieve this credit will increase.

5.3.2 EU13: Energy Efficient Building Form, Layout, and Orientation

Credit Description: "1 credit for demonstrating the fulfillment of at least 3 items out of the following strategies;

2 credits for demonstrating the fulfillment of all of the following strategies:

For residential developments:

a) To demonstrate compliance, energy simulation must be provided to show that the average solar irradiance of all facades is lower than 395 kWhr/m2/ Apr-Oct;

b) Compliance is demonstrated by showing that a site permeability of 20% can be achieved between assessed building and nearby buildings/obstructions;

c) Demonstrate that 20% of the habitable space can utilize natural ventilation either by the prescriptive approach or the performance approach;

d) Demonstrate that the OTTV of habitable spaces is less than or equal to 30 W/m2; and

e) Demonstrate that the VDF of habitable spaces are 50% more than the baseline requirements.

For all building types excluding residential:

a) Consideration of built form and building orientation to enhance energy conservation;

b) Consideration of optimum spatial planning to enhance energy conservation;

c) Consideration of building permeability provisions of building features to enhance the use of natural ventilation;

d) Provision of fixed or movable horizontal/vertical external shading devices; and

e) Provision of movable external shading devices for major atrium facade windows or skylights."

Proposed Solution: The team recommends that a definition of "natural ventilation" is given and what technologies can be used to achieve this credit are specified. The team also recommends more examples for "building orientation," such as providing shading on south facing windows to reduce solar gain and windows that open to the prevailing winds to enhance natural ventilation.

Justification for Solution: The addition of these examples contained in the proposed solution will help to clarify exactly what the credit requires of building developers. Therefore, they will fully understand what is required by the credit, and the contested rate of this credit will decrease.

5.3.3 SA8b: Microclimate Around Buildings – Elevated Temperatures

Credit Description: "1 credit for providing shade on at least 50% of non-roof impervious surfaces on the site (parking, walkways, plazas) using light colored high-albedo materials (albedo of at least 0.4); 1 credit for providing roof material that meets the Solar Reflectance Index (SRI) of 78 or vegetation roof covering at least 50% of the total roof area."

Problems: Respondents in the focus group explained that the Solar Reflectivity Index (SRI) of a material is frequently not provided by the manufacturer, and that the process for completing a lab test to obtain a certain material's SRI index is not straightforward. In addition, focus group participants expressed confusion as to the definition of "non-roof impervious surfaces". It is difficult to achieve the 50% cited in the credit, thus some applicants have given up on ever achieving this credit. Providing a green roof leads to the risk of water leakage, and since the roof may be sold to the top most occupiers in residential buildings, it may be out of the original developer's control.

Proposed Solution: Replace the "or" with an "and" at the end of assessment section (b), subsection (i). This will help to clarify that projects must achieve both parts of this credit, not just one or the other. Specify that the non-roof impervious surfaces are at street level, and that all EVAs, driveways, and podium gardens shall be counted as such. In addition, explain that underground car parks shall not be counted as non-roof impervious surfaces and state that concrete is not considered a light colored high albedo material. Lastly, reduce the percentage of non-roof impervious surfaces that must be shaded.

Justification for Solution: Through examination of various building reports, it was determined that the problems above were common reasons for the credit being failed. If this list of areas that do and do not count for non-roof impervious surfaces were to be added to the BEAM Plus handbook, it would both increase the clarity of the credit requirements and reduce the number of times that this credit was contested. In addition, the replacement of the "or" with "and" will improve the clarity of what must be done to achieve full credit. The focus group expressed that 50% was too high of a percentage for many buildings to achieve, so it is also suggested that there is a slight reduction in the percentage that must be covered.

5.4 Least Achieved Credits

The least achieved credits were examined by this project because they are overly difficult or even unrealistic for buildings to achieve. All of these credits are either achieved by very few or no projects at all. This is a problem because the environmental benefits that these credits would bring to Hong Kong are not being implemented. The team realized that these credits could be altered so that they maintain the intent of the credit and become more accessible for buildings to achieve.

The low achievement credits that the team focused on for this project were MA5, SA1, WU4b, IEQ19 (bonus), MA7c, MA3, and EU6 because they all have achievement of fewer than 5%. This was decided as the threshold because it meant that 5 or fewer building projects were achieving these credits.

These credits were generally addressed by breaking them down into sub credits that are more achievable in parts, making it more feasible for projects to gain some credit. Some of the credits were also reoriented to more accurately address certain buildings and needs in Hong Kong. It is also recommended for a number of these credits to be modified to more accurately represent what different building types are capable of.

5.4.1 MA5: Rapidly Renewable Materials

Credit Description: "1 credit for demonstrating 2.5% of all building materials/products used in the project are rapidly renewable materials. 2 credits where 5% of all building materials/products used in the project are rapidly renewable materials."

Problems: Rapidly renewable materials have less durability compared to conventional materials (especially in a structural setting), there are a very small number of these materials to choose from, and their maintenance is costly. Most importantly, while 2.5% rapidly renewable materials is feasible for small buildings, Hong Kong is predominantly skyscrapers, making that percentage very difficult to satisfy.

Proposed Solution: Break the credit into 2 sub-credits, one for interior use and one for exterior use, and make 2.5% a normal credit and 5% a bonus credit.

Justification for Solution: Respondents in the focus group expressed the opinion that it was unrealistic to use rapidly renewable materials in a typical Hong Kong building structure because they are not as durable as conventional materials. It is therefore suggested that the credit be divided into two parts, one for interior use and one for exterior use, because it makes it more possible for a building to achieve partial credit while also increasing its effective weighting by doubling the available points. By dividing the credit into two parts, and no longer considering rapidly renewable materials for use in structural applications, this credit should gain higher adherence. The credit also currently gives one point at 2.5% and two at 5%. The focus group noted that this percentage is too high so the team recommends that the 5% point be made into a bonus credit, which is sufficiently difficult for projects to achieve as to warrant a bonus point.

5.4.2 SA1: Contaminated Land

Credit Description: "1 bonus credit for conducting a site contamination assessment and implementing measures for rehabilitation, and/or proper preparation of sites and structures adjacent to landfill sites."

Problems: Risk is high with this credit, for if contamination is found in the project site during the assessment, the site must be remediated to gain credit. The fact that it is a bonus credit further hurts any chance of it becoming more frequently achieved, as the high risk is not worth a credit that will not affect the overall score if it is not attempted.

Proposed Solution: Split this credit into 2 parts, with 1 credit awarded for performing the site assessment and 1 credit for completing site remediation if any contamination is found.

Justification for Solution: Currently no site contamination assessments have been completed under BEAM Plus version 1.2. This can be changed by separating the required remediation from the site assessment itself, thus removing the potential delays that can arise due to remediation. While the hope is that all buildings will complete both a site contamination assessment and remedy any problems that are found, the team recognizes that this may be difficult to achieve at the current time. Therefore it was decided to split the credit into two parts to encourage site contamination assessments, from which normal site remediation would hopefully occur.

5.4.3 WU4b: Water Recycling – Recycled Water

Credit Description: "1 credit where recycled grey water will lead to a reduction of 5% or more in the consumption of fresh water."

Problems: Grey water is typically used for flushing toilets, but in Hong Kong seawater is used for this purpose, thus the usual use for grey water is not available. Grey water recycling is also more costly in maintenance and operation than the use of seawater. Space is a big problem for installing the treatment facilities since Hong Kong is a high-density city and there is no extra space available. The long term cost savings are also negligible for this water recovery method in Hong Kong.

Proposed Solution: Move this credit from the normal to bonus category and decrease the percentage from 5% to 2.5%.

Justification for Solution: While BEAM should continue to encourage grey water recycling, its common uses are not applicable to Hong Kong's needs. A building seeking to recycle grey water is going beyond what is easiest and simplest and is clearly is making this move for the environment alone. Therefore the credit should no longer be a normal credit but be changed to a bonus credit to continue to encourage the use of grey water recycling systems in Hong Kong. The percentage should also be reduced to encourage more buildings in Hong Kong to install grey water recycling systems.

5.4.4 IEQ19: Noise Isolation Between Rooms (bonus)

Credit Description: "1 credit for demonstrating impact noise isolation between floors meets the prescribed criteria."

Problems: The cost of installing a noise-isolating layer under flooring is too high and maintenance is a problem. This credit is currently only for residential buildings, but because it is a bonus many non-residential buildings do not apply for exemption. Thus the percentage of buildings failing this credit is inflated.

Proposed Solution: Expand the credit to include other building types. Potentially make it a normal credit.

Justification for Solution: Participants in the focus group expressed the opinion that this credit should be applicable to all building types, as currently it is only for residential buildings. This type of noise isolation would be beneficial in all building types for the comfort of the occupants and would be especially valuable in buildings such as hotels and hospitals. Switching this credit from bonus to normal status would also help to improve achievement because it would contribute to the denominator of a building's score.

5.4.5 MA7c: Recycled Materials – Interior Building Component

Credit Description: "1 credit where at least 10% of all building materials used for interior non-structural components are recycled materials."

Problems: This credit has a number of problems. First, the definition of "recycled materials" is not clear, and applicants do not understand the differences between "recycled materials" and "materials with recycled contents". Second, this credit is also not very practicable since there is a liability with the quality of these recycled materials. Third, the 10% requirement is also difficult to achieve for most applicants. Gathering supporting documentation is also a concern because it is complicated to procure third party proof for recycled materials.

Proposed Solution: Modify the credit description for all sections to: 1 credit where at least 10% of all building materials used for interior non-structural components are recycled materials or materials with recycled content amounting to a total of 10% of all materials used being from recycled sources. For example, if 20% of materials used have a 10% recycled content then that counts as 2% of all materials. The recycled content change can be applied to all sub credits in MA7. The percentage for interiors should also be lowered to 7.5%.

Justification for Solution: The focus group respondents expressed the opinion that this credit was more frequently achieved in previous versions of BEAM because of the ability to use materials with recycled content. However, previous versions of BEAM did not count materials with recycled content in the manner suggested, which is why they are included in the proposed change. The inclusion of the materials with recycled content portion of the credit, along with the new method for calculating percentage of the materials, maintains the environmental benefits of this credit while increasing its accessibility.

5.4.6 MA3: Prefabrication

Credit Description: "1 credit when the manufacture of 20% of listed prefabricated building elements has been off-site; 2 credits where the manufacture of 40% of listed prefabricated building elements has been off-site."

Problem: This credit can easily be achieved by residential buildings but is much more difficult for non-residential buildings.

Proposed Solution: Make separate credit thresholds for different building types. Keep residential buildings at 20% and 40% and make nonresidential 10% and 20% respectively.

Justification for Solution: The focus group conveyed to the team that this credit was very achievable for residential buildings, but much less so for nonresidential buildings. Based on this knowledge the team has left the credit as it was for residential buildings, but reduced the threshold for non-residential buildings. This will enable non-residential buildings to begin gaining credit for MA3. In the future the requirements for non-residential buildings can be made more rigorous.

5.4.7 EU6: Renewable Energy

Credit Description: "1 to 5 credits where 0.5% to 2.5% or more of building energy consumption is obtained from renewable energy sources respectively. Alternatively, 1 to 5 credits where the minimum percentage of 20% to 100% of the building footprint is being covered/used by PV panels respectively and/or other renewable power facility generation with equivalent renewable power output."

Problem: The current alternative method requires 20-100% of the building footprint to be covered by PV panels, which is unrealistic.

Proposed Solution: Reduce the scaling of this credit from 20%-100% to 18%-90% and specify that it concerns the percentage of the area that is not already occupied by other BEAM credit requirements, like rooftop greening.

Justification for Solution: Currently, in order to gain full points for this credit the entire building footprint must be covered by renewable energy sources. This is unrealistic, as it leaves no space on the roof for the necessary maintenance access and/or things such as a green roof. By making the suggested changes to the alternative method, these problems should be solved and achievement should increase.

5.5 High Achievement Bonus Credits

Bonus credits that have high achievement were addressed in this project because bonus credits can only be positive points for a building. Bonus credits should be more difficult than normal credits because they do not contribute to the denominator of a building's score. If bonus credits can be easily achieved, then why not make them contribute to the denominator by changing them to normal credits, or make them more difficult so that they can be deserving of bonus status. It is the opinion of the team that bonus credits should be difficult to achieve, because by achieving them the building designers are showing that they are going beyond what is required and gaining points for tasks that are not required by BEAM.

The team focused on IEQ16, SA5, and EU10e because they are the three bonus credits with achievement above 30%. After these three credits there are very few bonus credits satisfied until achievement is just over 10%, which is appropriate for bonus credits because of their difficulty.

In general, the high achievement rate bonus credits enjoy is addressed by changing them to normal credits. This causes these credits to contribute to the denominator of the score and will encourage buildings to seek points from other credits, increasing achievement of other BEAM Plus standards as well.

5.5.1 IEQ16: Interior Lighting (bonus)

Credit Description: "1 BONUS credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zones and/or occupancy sensors."

Problem: It is currently a bonus credit but it has achievement of 30%, which is much higher than most other bonus credits. Bonus credits do not contribute to the denominator of the BEAM score of a building. Thus they should be more difficult than normal credits. A normal credit should be reasonably achievable for all buildings because if the credit is not achieved it detracts from the score. Bonus credits should be for the buildings that seek the extra points even though they are more difficult. With this in mind, the fact that IEQ16 Bonus has 30% achievement is a problem because it can easily be used to replace a not achieved normal credit.

Proposed Solution: The team recommends that IEQ16 Bonus is changed to a normal credit.

Evidence for Solution: IEQ16 Bonus is not a difficult credit to achieve and thus it should be made a normal credit. This would prevent the credit being used to easily increase the score of a project. It is the opinion of the team that bonus credits should be difficult to achieve and IEQ16 bonus is not difficult enough to be a bonus credit.

5.5.2 SA5: Ecological Impact

Credit Description: “Having a site which scores less than 20% of the points in the Habitat Section of The Nature Conservation Policy - 2009[1] and having a site which scores less than 30% in the Biodiversity Section of The Nature Conservation Policy - 2009; or Demonstrating that appropriate design measures have been implemented to contribute positively to the ecological value of the site.”

Problem: SA5 is a bonus credit yet has a nearly 50% achievement rate.

Proposed Solution: Change SA5 from a bonus credit to a normal credit.

Justification for Solution: SA5 is the highest achieving bonus credit with an achievement of 47.3%. It can easily be used to increase the score of a project, but it has no impact on the denominator. By changing the credit to a normal credit it will gain an effect on the denominator of the score and cause buildings to seek any desired credits elsewhere.

5.5.3 EU10e: Testing and Commissioning – Independent Commissioning Authority

Credit Description: "1 BONUS credit for engagement of an independent commissioning authority in the Testing and Commissioning process."

Problem: EU10e is a bonus credit with an achievement rate of 33%, which is too high for a bonus credit.

Proposed Solution: Change EU10e from the bonus category to the normal category.

Justification for Solution: EU10e is the second highest achieving bonus credit with an achievement of 33.0%. It can easily be used to increase the score of a project, but it has no impact on the denominator of the final score. By changing the credit to a normal credit it will gain an effect on the denominator and cause buildings to seek credits elsewhere.

5.6 Proposed New Credits

During the course of the project, the team both gathered opinions and data from the public about improvements that can be made to BEAM, and became familiar with some of the issues that have arisen around building design. From this data, the team developed ideas for additional credits that would factor in influencing the public opinion of BEAM. These credits concern the public enjoyment of BEAM buildings, the distinct culture of China, the full environmental impact of materials, the user friendliness of green technologies, and the opinions of BEAM building occupants.

5.6.1 Quality Public Spaces Credit

Suggested Credit: 1 SA credit for providing public spaces for various activities, including but not limited to: artistic performances, sports, picnics, restaurants, and shopping within the building or on the building site.

Justification for Addition: The team recommends the addition of a credit regarding the provision of public facilities in BEAM buildings. This credit requirement would award points if a building provided space for the public to engage in various activities such as artistic performances, sports, picnics, restaurants, and shopping. The addition of this credit would enable BEAM to encourage buildings to be more enjoyable places to spend time in. During the site visits, the project team noticed that some BEAM buildings, while impressive in their environmental considerations, did not facilitate, or even restricted, human activities. In essence, these buildings were not humanized. There were beautiful rooftop gardens and amazing views at some of these buildings, but there was nothing else to do there. Surveys conducted showed that the public agreed with this sentiment. This could be changed by adding a credit requirement that provides points for the quality design of public spaces that offer activities and performances available to the public. The team realizes that public spaces are contained under the credit SA3c, which states: “1 credit where at least 2 different recreational facilities or at least 5 different basic services are located within the Site and will be made available for public use.” However, this credit makes no provisions for the quality of public spaces, nor well defines them. The team believes that this credit is best as a normal credit with exclusions for buildings that are not accessible to the public.

5.6.2 Cultural Consciousness Credit

Suggested Credit: 1 SA credit for constructing a building with consideration for cultural aspects unique to Hong Kong, e.g. with adequate Feng Shui considerations.

Justification for Addition: Due to media coverage of this issue, the team recommends that BEAM Plus should include 1 bonus SA credit for having a building design that considers the unique culture of Hong Kong. This credit should be added because some BEAM Plus buildings are said to be bad for the Feng Shui of the district/community. If a credit of this nature were added to BEAM Plus it would cause such buildings to be built less frequently. Including this credit would also show that BEAM Plus is conscious of the cultural beliefs in Hong Kong. The cultural credit should be a bonus credit because it should not negatively impact the score of a building if the building owner does not believe in Feng Shui and does not wish to have their building design evaluated for it. This credit should be put into Site Aspects because the Feng Shui of the building is part of the site and external design of the building.

5.6.3 Environmental Product Declaration Credit

Suggested Credit: 1 MA credit for including low carbon materials, as well as submitting a life cycle assessment of the environmental aspects of these materials.

Justification for Credit: The team recommends the addition of a credit to encourage buildings to use more low carbon materials. The reduction of carbon embodied in building materials would reduce the amount of greenhouse gases released into the air. If this credit were added to BEAM Plus then it would cause building designs to include more low carbon materials to reduce their carbon footprint. From the sites the team visited they believe that greater inclusion of low carbon materials in building is something that is achievable for many buildings. In fact, credit EU3 deals with building materials: “1 credit for demonstrating the embodied energy in the major elements of the building structure of the assessed building has been studied through a Life Cycle Assessment (LCA).” However, EU3 is based on the preliminary choice of a material, not on the actual product that is purchased. Multiple buildings that the team visited had already adopted the use of low carbon materials, such as “Starfon”, without receiving BEAM credit for them. It is the belief of the team that these projects should receive credit and BEAM Plus should seek to spread the use of low carbon materials through the addition of this credit. The team believes that it would be best as a normal credit as there are already multiple buildings in Hong Kong that use low carbon materials and it would not be difficult for most buildings to achieve.

5.6.4 Ergonomics, User Friendliness, and User Education of Green Technologies Credit

Suggested Credit: 1 IEQ credit for providing ergonomic and user friendly green technologies in a building, as well as appropriate education for their use (such as instruction plaques).

Justification for Credit: Through the site visits to BEAM certified buildings, the team noticed that some green technologies were not in use due to poor user friendliness. For example, windows that were designed to provide natural ventilation, but were opened from the top of the window. The design may have seemed sound during the design phase, but users of the window were forced to employ a ladder to open it. In addition, devices such as electric thermostats and food composting waste baskets were installed but not used, since occupants did not know how to use them. By encouraging user education for these devices, they can be an integral part of the "greenness" of the building they occupy.

5.6.5 User Feedback and Fine-Tuning After Occupancy Credit

Suggested credit: 1 IEQ credit for evaluating the opinion of the users (occupants, tenants, etc.) on their BEAM building's livability every year.

Justification for Credit: Many buildings change/remove the green technologies that were implemented when they were first BEAM certified due to factors such as usability and poor performance. Evaluating the opinion of users of the green technologies in a BEAM building can identify which devices are causing problems, as well as help formulate solutions to make a building greener.

5.7 Changes to the BEAM Scoring System

While the team was primarily charged with developing changes to the specific credits in BEAM Plus, they also saw possibilities for other improvements that could be proposed. While the origins of these changes vary, they are all changes made to how the BEAM Plus score of a building is calculated.

The one change to the BEAM scheme that the team recommends is that the number of required IA credits to obtain a Platinum, Gold, or Silver rating be reduced by 1 for all projects. The team recommends this change because of the suggested alteration of IA3 to a prerequisite. This would reduce the achieved IA credits of all buildings by one. To counteract this, the number of required IA credits should be reduced. This reduction will maintain the current requirements for IA1 and IA2 as they currently stand.

The team also recommends a change in the weightings of the credit categories. The focus group participants mentioned that the reason that Material Aspects (MA) credits tend to have lower adherence is that they have a low weighting at 8%. They also expressed that they felt that Site Aspects (SA) were weighted more heavily than they had to be at 25%. For this reason, the team recommends that 2% of weighting be shifted from SA to MA, making the new weightings 23% and 10% respectively. This would be beneficial to the BEAM Plus system as a whole because it will increase the adherence of all MA credits since they would be worth more for the final score of the building. This change would also make SA worth a bit less for buildings, however this should not have a major negative impact because SA will still be the second most heavily weighted. By making this change, future versions of BEAM Plus can address the generally low adherence of the MA area of BEAM Plus.

The final change that the team would make to BEAM Plus is a change in the score to achieve an Unclassified level from 0% of credits to 10% of credits. Currently, in order to achieve an Unclassified rating from BEAM a project must only achieve the prerequisites in each aspect category, which are generally easy to achieve. A number of buildings will stop after achieving only the prerequisites and achieve no actual credits. This is a problem because a BEAM certification of any level can be used by buildings to claim extra Gross Floor Area (GFA) concession. With this concession, a building can exempt up to 10% of its floor area from any assessments, such as tax forms. As one can imagine, 10% of the floor area of a skyscraper is a large space, and in turn a large amount of money is saved. The team does not believe that a building should be able to do nothing in the BEAM scheme and gain this reward. If this percentage threshold existed in the current version of BEAM Plus, 15 buildings would have failed to become Unclassified. Of those buildings, 7 received no credit whatsoever and 6 only received one credit for having a BEAM Plus professional on their project team. That means that only two projects that achieved any credits apart from having a BEAM professional would have failed. This change would help to strengthen the requirements for claiming extra GFA because buildings could no longer achieve only the prerequisites.

5.8 Solutions to the Limitations of BEAM

As the team has mentioned previously, the BEAM system is certainly not perfect, and there are criticisms that have not been addressed, e.g. the current system only looks at documents and photos when assessing a building project, making it easy for buildings to "game the system" and submit misleading evidence. Currently, the majority of building projects assessed under BEAM have only reached the Preliminary Assessment (PA) stage, with only three out of 110 projects reaching the Final Assessment (FA) stage. Thus, the BEAM achievement level of a building only reflects its design stage, not the finished building. The team suggests the following three changes to the BEAM scheme to remedy this problem:

1. Introduce policy incentives to encourage more building projects to reach the FA stage, e.g. setting a deadline for completing the FA or else additional BEAM assessment fess will be incurred
2. For the FA stage, consider mandating a site audit, conducted by a BEAM representative in person, to eliminate the limitations of document and photo review
3. For the post-FA stage, introduce a "live" green label, which would compare the actual energy and water consumption of a building each year compared to the initial design values. "Live" means that this label should change in line with the actual operations and maintenance (O&M) of a building

The team believes that these changes will encourage more buildings to follow through with their commitment to the environment.

5.9 Changes to Government Policies

The final two changes the team would like to propose are not for the BEAM scheme itself, but for the policies of the Hong Kong government. Currently the government grants a GFA (Gross Floor Area) concession for any BEAM level, including Unclassified. To achieve an Unclassified rating, a building is only required to achieve the prerequisites in each aspect category, which is generally easy to do. A number of buildings will stop after achieving only the prerequisites and achieve no actual credits. In essence, a building can claim extra GFA without achieving any BEAM credits. Thus, the first change the team suggests to the government policies concerning GFA is as follows: mandate that a building cannot be granted a GFA concession for any BEAM level less than Bronze. This change would encourage buildings to achieve more credits and work harder to both benefit the environment and their bottom line.

The second change concerns the data analysis that was performed on the types of buildings that achieve certain BEAM levels. It was found that 100% of buildings owned by statutory bodies, 57% of public residential buildings, and 66% of government-owned buildings achieved a BEAM Platinum level. The current government policy is that all government buildings must achieve at least a Gold BEAM level, or an equivalent level in an overseas green building scheme. Due to the percentages just cited, it is not unreasonable to change the policy to mandate Platinum level instead of just Gold. By doing this, the government can set an example for other buildings, achieving the absolute highest rating instead of the second best.

6. Summary

This project was designed to improve the BEAM Plus scheme through a review of all credits, making improvements to these credits and the rating system as a whole. The team has made recommendations to improve achievement of the least frequently achieved credits by making them more realistic for buildings to complete and breaking them into smaller sub-credits that are more manageable for building designers. The team has also made recommendations for changes to the most frequently contested credits to increase their clarity and specificity. The last major credit area that the team addressed was the credits that were most frequently achieved. The changes to this credit area involved reducing the available points and increasing the rigorousness of the credits. The team also observed areas of building design and operation that were not addressed by BEAM, and thus have outlined additional credits to make BEAM a standard that more thoroughly addresses every aspect of a building's life. With the set of recommendations that were made in this paper, it is the belief of the team that the next version of BEAM Plus will be even more environmentally beneficial and more buildings will achieve BEAM ratings.

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Appendix A: Background of the Hong Kong Green Building Council

The Hong Kong Green Building Council (HKGBC) is a non-profit, member led organization established in 2009 that promotes the standards and development of green buildings in Hong Kong. By engaging the public, industry, and the government, they strive to raise awareness about green buildings. Using a strategy named the "6As": Accreditation, Assessment, Award, Advocacy, Accelerate, and Advance, they have become a trusted authority on green construction. The HKGBC is one of 98 Green Building Councils worldwide, and is one of the 27 Established Members of the World Green Building Council (WorldGBC).

The assessment tool created by the HKGBC to certify green buildings, BEAM Plus, was created in April 2010. In August 2013, they launched BEAM Plus Interiors, which widened the scope of the previous BEAM Plus standards to include fit-outs, renovations, and refurbishment projects of non-domestic occupied spaces within buildings.

Long term goals of the HKGBC focus on their flagship plan called HK3030, which is a roadmap to reduce the electricity consumption of buildings in Hong Kong by 30 percent of 2005 levels by the year 2030. So far, they have issued 25 specific recommendations to help buildings reach this goal.

Structure of the HKGBC

Board of Directors:

To approach the vast scope of the transforming of Hong Kong's built environment, and navigate the challenges it presents, clear leadership is a priority. To guide the council's overarching activities, the Board of Directors provides oversight and leadership, and sets the direction for achieving the vision and mission.

Finance and Executive Committee (FEC):

Insures strict operating standards and maximizes resources to support HKGBC activities for achieving its mission by making management and financial decisions and monitoring operational performance.

Communications and Membership Committee (CMC):

Promotes industry developed labels for comprehensive environmental performance assessment schemes of green buildings by defining and steering strategic development, policies, processes, advocacy and promotion.

Industry Standards and Research Committee (ISRC):

Initiates and steers the development of industry standards, best practices, and application research in green building through defining research agendas and executing related activities.

Public Education Committee (PEC):

Promotes community and industry awareness on how people's actions affect the built environment and contribute to positive change by defining the green building education roadmap and initiatives through the HKGBC's education agenda and collaborating with curriculum bodies, schools and universities.

Appendix B: Examples of Green Features in Buildings

Urban Window:

Large openings at lower levels of the building, which allow efficient air flow and improve the micro-climate of the area.

Mixed Mode Ventilation:

The system solves a common problem of inadequate natural ventilation in most commercial buildings with glass curtain walls. The operable vents offer a choice to tenants to use free cooling instead of air conditioning.

Ventilation Doors on the Ground Floor:

In favorable weather conditions, two pairs of ventilation doors can be opened in a mall, allowing businesses and pedestrians to enjoy fresh air and reducing the need for air conditioning.

Natural Lighting System:

Light shelves and solar shadings utilize and enhance natural lighting, thus reducing energy consumption.

Energy Optimization Solution (EOS):

Designed to optimize the energy consumption of the central air-conditioning system, EoS responds to the real-time system load and changes in the external weather condition to continually monitor and control different system components.

PowerBox TM Web-based Energy Management Analysis and Monitoring System:

This energy-consumption monitoring and analysis system allows more effective management of the building performance. It provides a remote access network for monitoring, and generating reports for verifying building system operations and identifying system improvements – anywhere, anytime. It is designed to help reduce building energy consumption.

Pattern Recognition Energy Saving Solution (PRESS):

Using CCTV cameras and pattern recognition software, this system controls the building's lighting and air conditioning systems to reduce consumption by up to 50% according to the actual occupancy of the area, avoiding any unnecessary direct impact on occupants.

Starfon TM (a low-carbon green building material):

Starfon is a patented green building material that does not release any toxic substances in production and can be fully recycled. The finished product can be used to replace wooden floors, tiles, marble and other building materials, thus reducing the use of natural materials and posing no threat to the environment. It can also be combined with concrete and optic fiber to create a wide variety of transparent products.

Energy-Efficient Lift System:

Lifts are operated by permanent magnet motors with higher efficiency, attributing most of the project's total energy savings.

Single Aspect Design:

Block disposition and details in design promote natural ventilation, reduce direct solar penetration, and help to mitigate traffic and railway noise.

Two-Stage Lighting Control System:

The system adjusts the luminance of lighting in public spaces based on people's needs, thus reducing unnecessary lighting and enhancing energy conservation.

Smart Meter System:

Smart meters record electricity consumption in all public spaces, thus enabling prompt adjustment and management of unusual conditions.

Optimized Orientation of Buildings:

Buildings are oriented north-south, reducing exposure to solar heat gain from the east/west and therefore lowering the need for air conditioning. The windows on the north and south elevations can also take advantage of longer daylight hours for enhanced natural light.

Landscaped Deck and Pedestrian Zones:

Building separation is widened between buildings and permeability at pedestrian level is enhanced for natural ventilation, thus reducing the need for air-conditioning systems and reducing overall power consumption.

Energy-Saving Luminaries, LED Lighting Panels:

Replacing original T5 fluorescent tubes with LED.

Appendix C: Questions for Focus Group

1. What do you think is the reason that MA 5 (i.e. at least 2.5% of all building materials used are rapidly renewable materials) is <u>least attempted</u> by applicants? If BEAM Plus Guidebook is to be revised, what do you think would be an appropriate change to this requirement?

2. What do you think is the reason that WU 2 (i.e. water leakage monitoring) is one of the most <u>highly contested</u> credits? Did any of your projects submit for the credit and were you denied? If so, what was the reason for your denial? If BEAM Plus Guidebook is to be revised, what do you think would be an appropriate change?

3. SA1 is the credit regarding site contamination assessment and implementing measures for rehabilitation, and/or proper preparation of sites adjacent to a landfill. It is one of the credits that are often <u>not submitted</u>. There are two facts to note: (i) It is a BONUS credit, meaning that it does not form part of the base when calculating the scores. (ii) The Guidebook states that exclusions include greenfield sites, and sites where contamination/landfill gas assessment and mitigation are statutory requirements. For brownfield sites, the Guidebook does not state which sub-groups of brownfield sites can be excluded. What do you think is the reason that this credit is often not submitted? Any change to the Guidebook you would like to suggest?

4. WU4b (grey water recycling) is one of the normal credits that are often not submitted. What do you think is the reason? If BEAM Plus Guidebook is to be revised, what do you think would be an appropriate change?

5. IEQ 19b Bonus credit concerning impact noise isolation between the floors of residential building (requiring an isolation level of at least IIC52) has a very low achievement rate and one of the frequently not submitted credits. What do you think is the reason for this? If BEAM Plus Guidebook is to be revised, what do you think would be an appropriate change?

6. SA8b, i.e. providing shade on at least 50% of non-roof impervious surfaces (parking, walkways, plaza) using light-colour high-albedo (>0.4) materials, and/or providing roof material that meets the solar reflectance index of 78 or vegetation roof covering at least 50% of the roof, is highly contested. What do you feel is the cause of this? Did any of your projects submit for the credit and were you denied? If so, what was the reason for your denial? If BEAM Plus Guidebook is to be revised, what do you think would be an appropriate change?

7. To gain credits for MA7, at least 10% of all materials used in (a) exterior, (b) structure, or (c) interior of a building shall be recycled materials. Each part of this credit has low achievement (i.e. not submitted) but the worst by far is for the interior. Can you think of a particular challenge that the interior has over the other two elements or that the use of recycled materials has as a whole? What change to BEAM Plus would you suggest?

8. MA3 requires the off-site prefabrication of at least 20% of the listed building elements within 800 km of the site. It is one of the frequently not submitted credits. What is the challenge in meeting this requirement, and what change to BEAM Plus would you suggest?

Appendix D: Questions for Occupants

Please circle the answer that best describes your response to the following questions:

Strongly Agree

Neutral

Strongly Disagree

1. Are you aware that this building is BEAM certified?	NO				YES
2. Would you consider the cruise terminal to be a “green building”?	NO		Indifferent		YES
3. Would the garden be improved if there were more space to walk along the edge	NO		Indifferent		YES
4. The BEAM certification of this building impacted my choice in visiting it.	1	2	3	4	5
5. This building was easy to access.	1	2	3	4	5
6. This is a vibrant space to be in.	1	2	3	4	5
7. The temperature around this building is ___________ compared to the rest of the city?	Much cooler	A little cooler	About the same	A little warmer	Much warmer

Are there any activities would you like there to be in this place? If yes, what activities?

Additional Comments:

Appendix E: Checklist for Site Survey

- ☐ Use of Daylight sensors
    - ▪ Does the lighting dim near the window?
- ☐ Task Lighting
    - ▪ Lamps on the desk?
    - ▪ Did the occupants take it away?
- ☐ Natural Ventilation
    - ▪ Is the AC off?
    - ▪ Specifically G/F common area and 1/F office common corridor
- ☐ Low Tap Faucets
    - ▪ Is one push enough to wash your hands?
- ☐ Disabled accessibility
- ☐ Roof Garden
    - o 1 to 5. 1 being not there, 5 being awesome
- ☐ Acoustics
    - o 1 to 5. 1 being awful, 5 being pretty nice
- ☐ Air Quality
    - o 1 to 5. 1 meaning 'cannot breathe', 5 meaning great
- ☐ Lighting
    - o 1 to 5. 1 being dark and hard to see. 5 being great

Appendix F: Questions for Building Management/Operators

1. How would you rate the success of green technologies in your building? (very low- high)

   Do you feel that the BEAM requirements you have in place are having the desired effect?

2. Are there any other comments you have regarding BEAM that you would like to share with us?

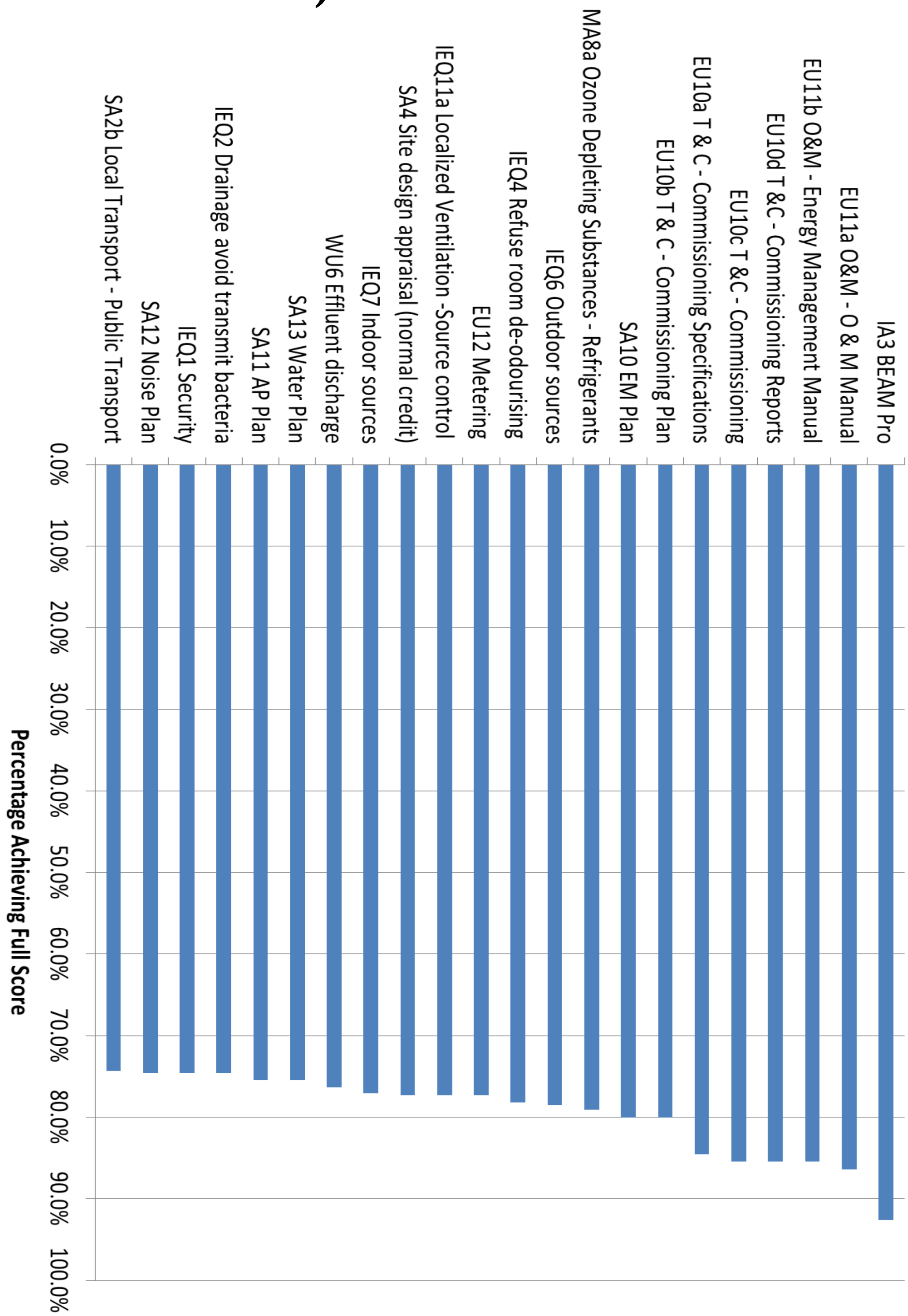
3. What was the reason for getting your building BEAM certified?

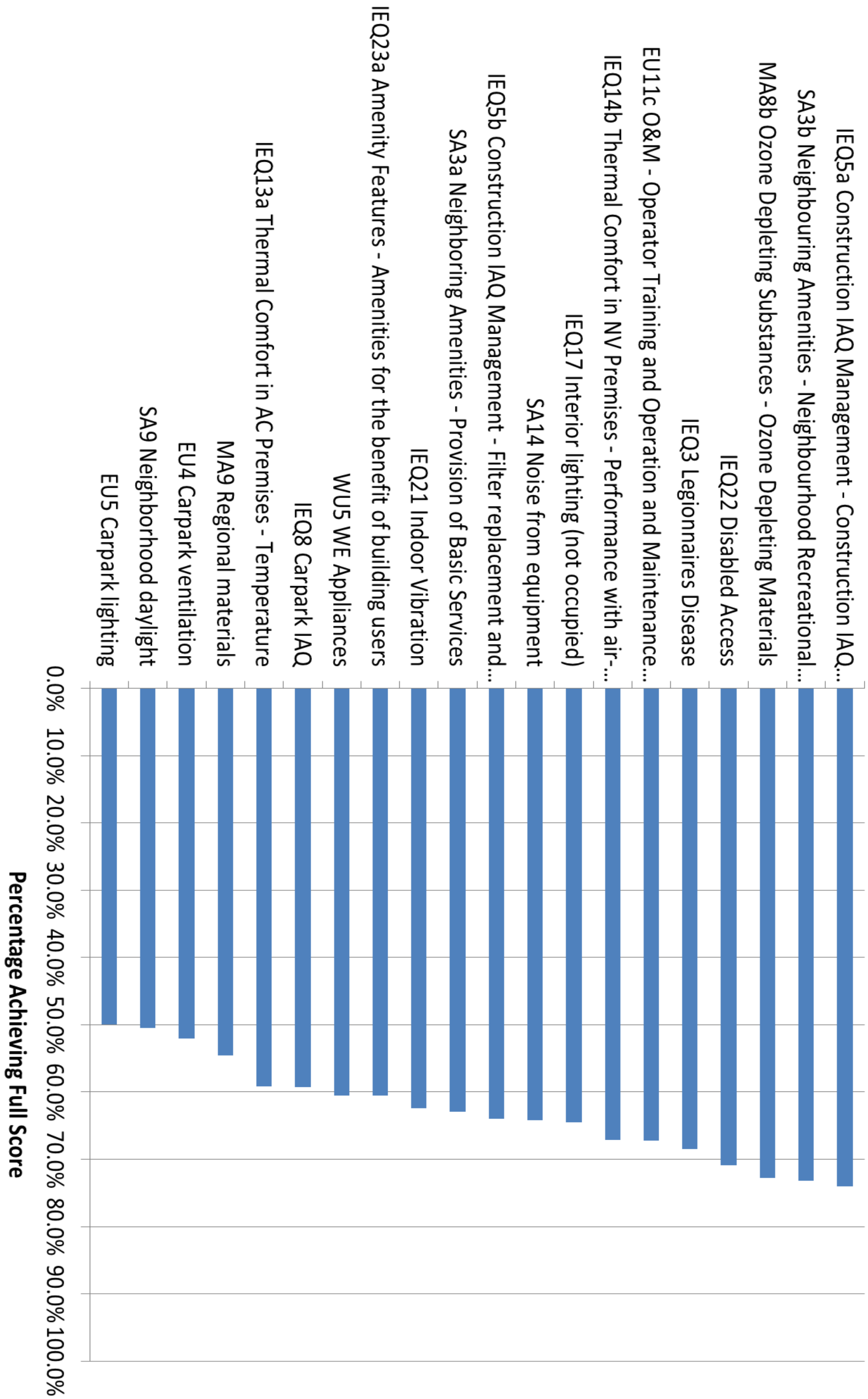
4. Do you think it was worth the extra effort to get your building BEAM certified?

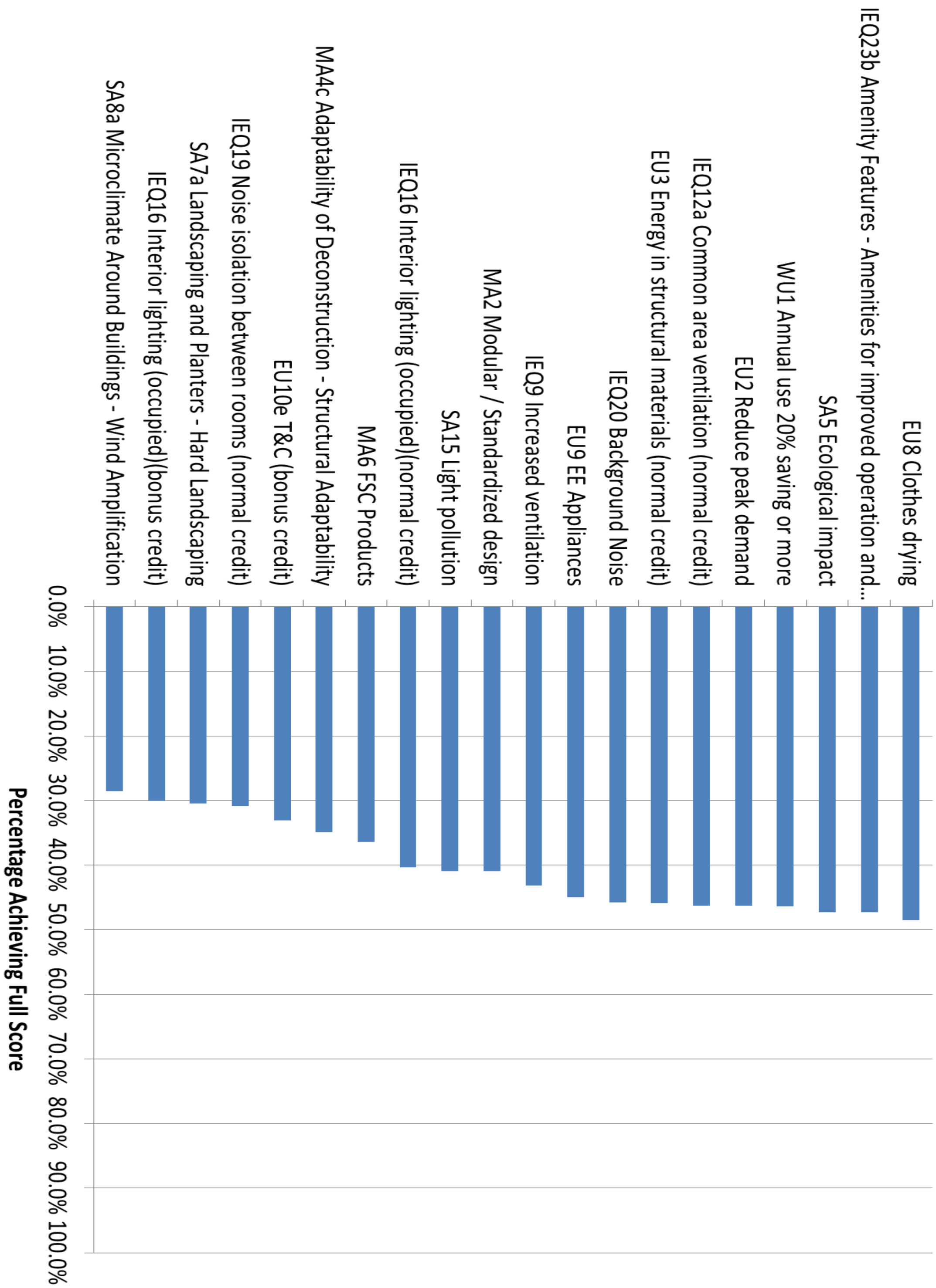
5. What sort of feedback have you received from occupant/ operators about green technologies?

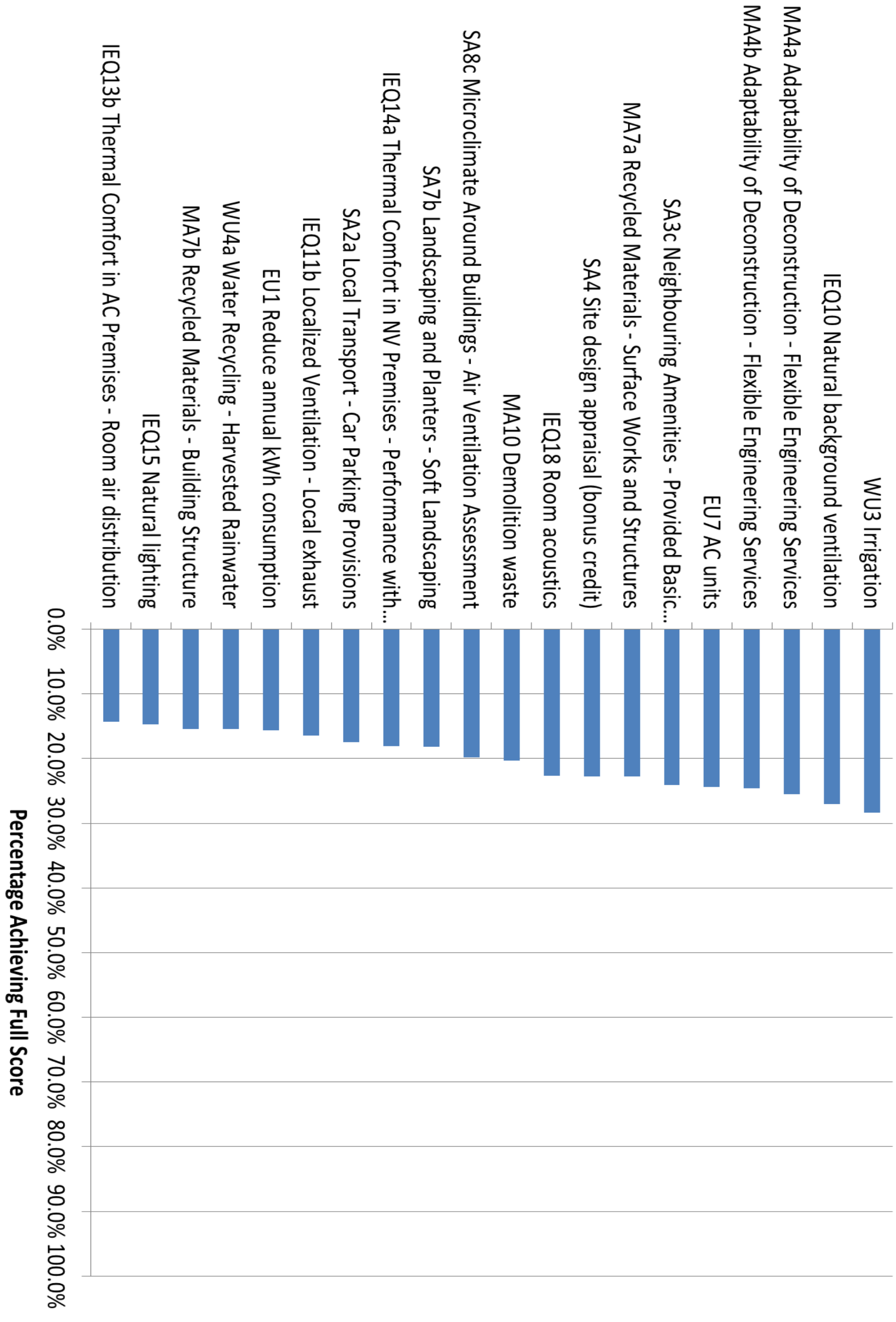
6. How are the following technologies working:
   a. Water conservation technology
   b. Energy conservation technology
   c. Natural ventilation systems
   d. Air quality
   e. Climate control
   f. Lighting
   g. Acoustics

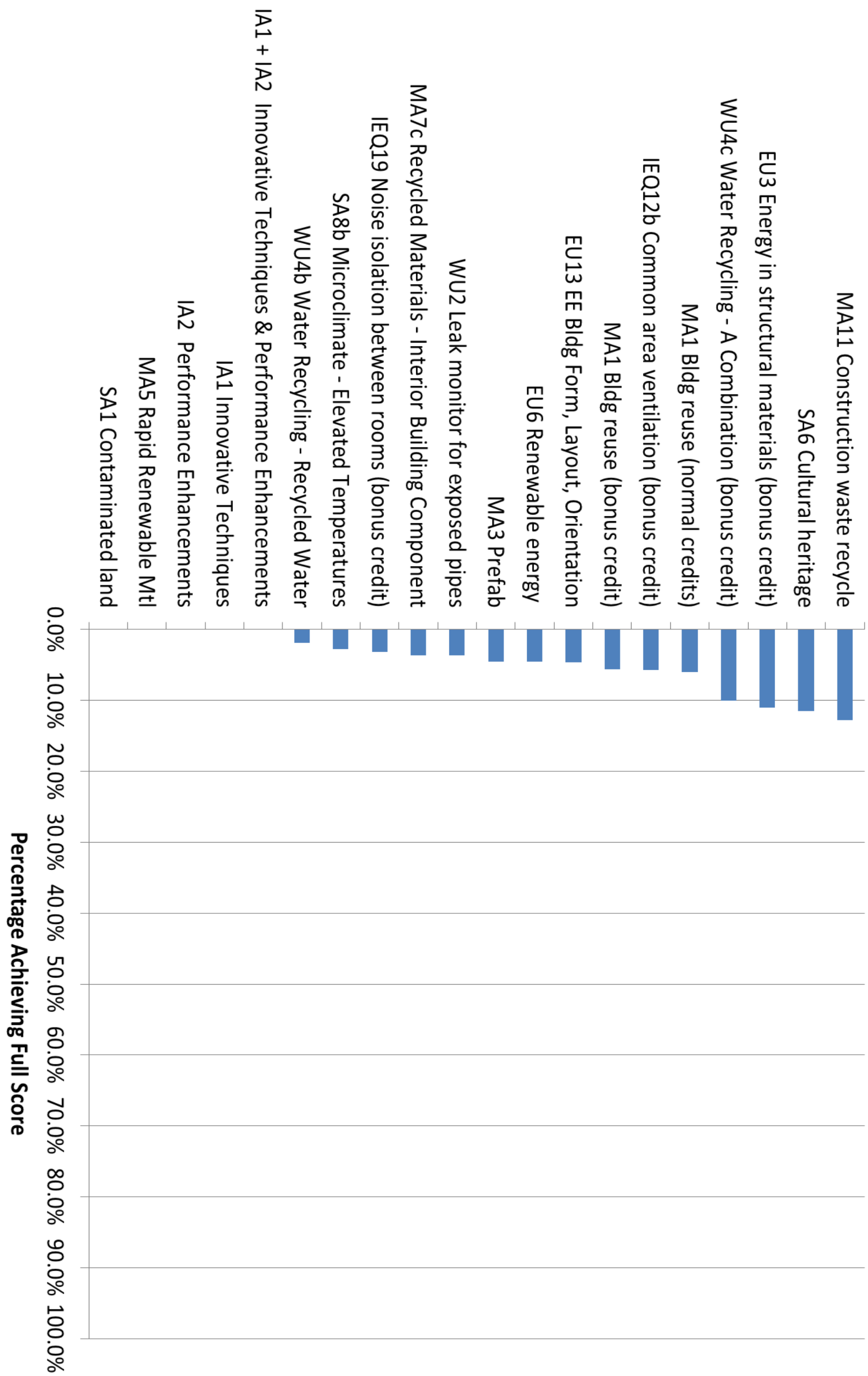
Appendix G: Achievement of All Credits (Achievement Order)




IEQ5a Construction IAQ Management - Construction IAQ...
SA3b Neighbouring Amenities - Neighbourhood Recreational...
MA8b Ozone Depleting Substances - Ozone Depleting Materials
IEQ22 Disabled Access
IEQ3 Legionnaires Disease
EU11c O&M - Operator Training and Operation and Maintenance...
IEQ14b Thermal Comfort in NV Premises - Performance with air-...
IEQ17 Interior lighting (not occupied)
SA14 Noise from equipment
IEQ5b Construction IAQ Management - Filter replacement and...
SA3a Neighboring Amenities - Provision of Basic Services
IEQ21 Indoor Vibration
IEQ23a Amenity Features - Amenities for the benefit of building users
WU5 WE Appliances
IEQ8 Carpark IAQ
IEQ13a Thermal Comfort in AC Premises - Temperature
MA9 Regional materials
EU4 Carpark ventilation
SA9 Neighborhood daylight
EU5 Carpark lighting
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

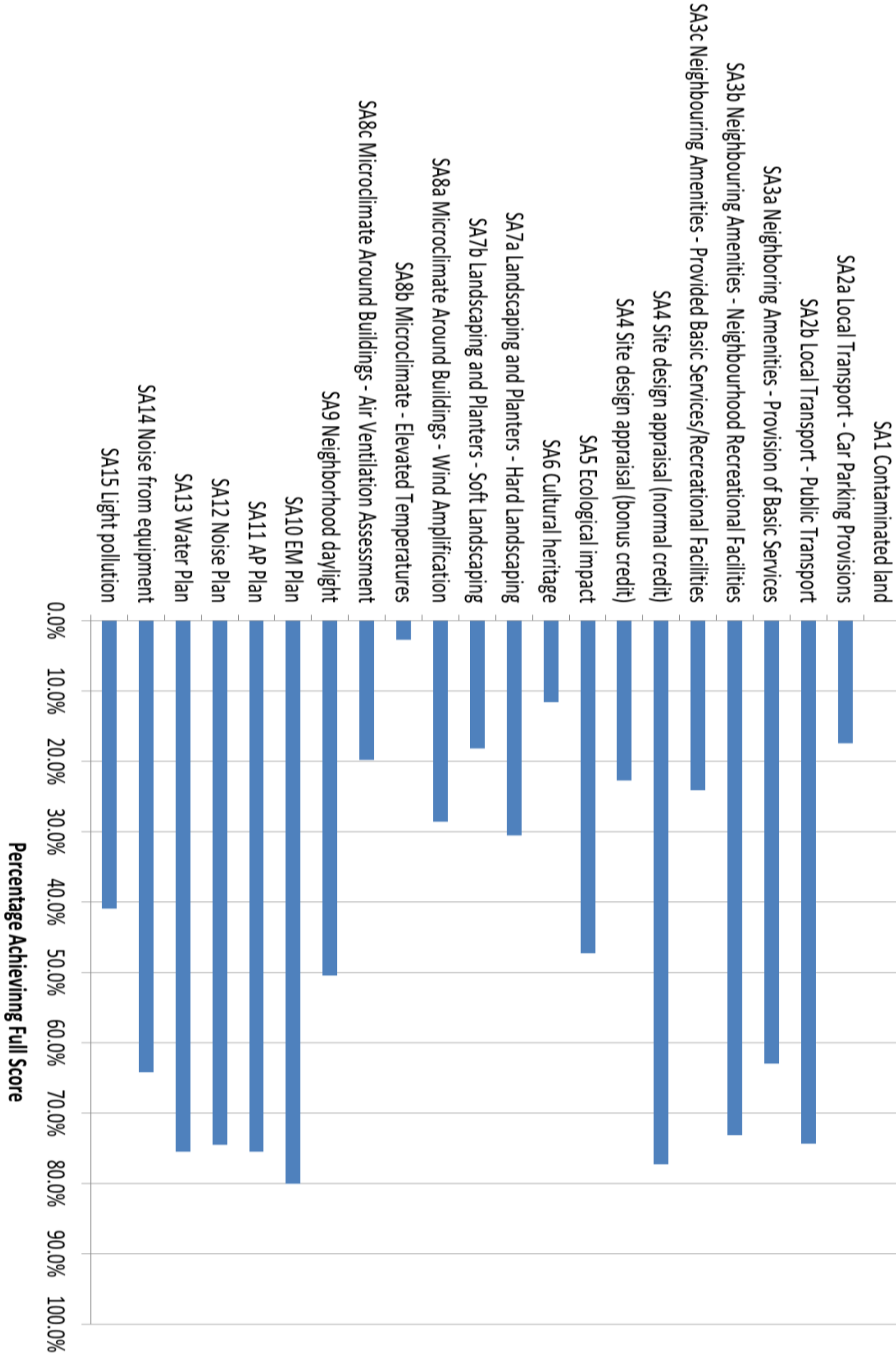

EU8 Clothes drying
IEQ23b Amenity Features - Amenities for improved operation and...
SA5 Ecological impact
WU1 Annual use 20% saving or more
EU2 Reduce peak demand
IEQ12a Common area ventilation (normal credit)
EU3 Energy in structural materials (normal credit)
IEQ20 Background Noise
EU9 EE Appliances
IEQ9 Increased ventilation
MA2 Modular / Standardized design
SA15 Light pollution
IEQ16 Interior lighting (occupied)(normal credit)
MA6 FSC Products
MA4c Adaptability of Deconstruction - Structural Adaptability
EU10e T&C (bonus credit)
IEQ19 Noise isolation between rooms (normal credit)
SA7a Landscaping and Planters - Hard Landscaping
IEQ16 Interior lighting (occupied)(bonus credit)
SA8a Microclimate Around Buildings - Wind Amplification
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

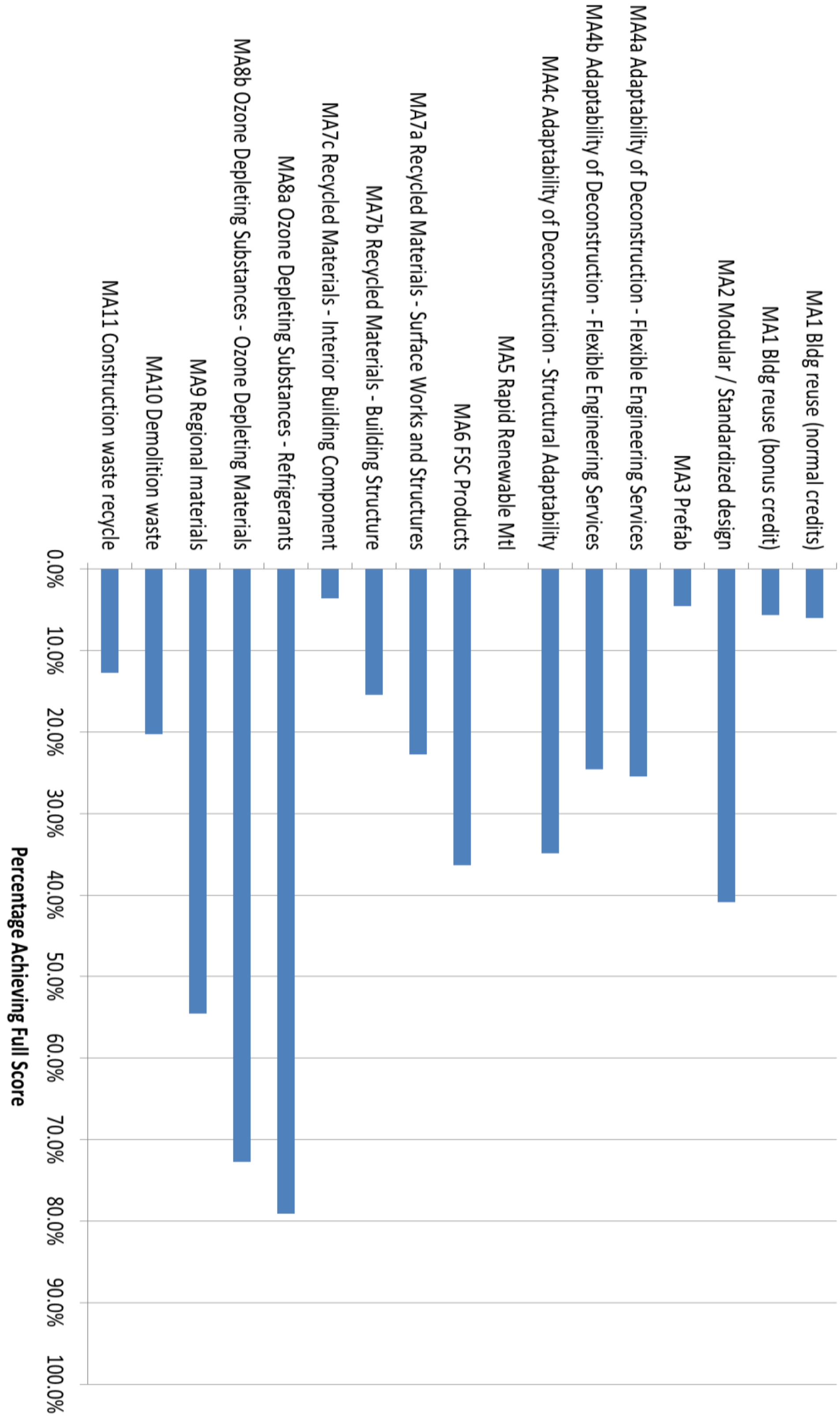

WU3 Irrigation
IEQ10 Natural background ventilation
MA4a Adaptability of Deconstruction - Flexible Engineering Services
MA4b Adaptability of Deconstruction - Flexible Engineering Services
EU7 AC units
SA3c Neighbouring Amenities - Provided Basic...
MA7a Recycled Materials - Surface Works and Structures
SA4 Site design appraisal (bonus credit)
IEQ18 Room acoustics
MA10 Demolition waste
SA8c Microclimate Around Buildings - Air Ventilation Assessment
SA7b Landscaping and Planters - Soft Landscaping
IEQ14a Thermal Comfort in NV Premises - Performance with...
SA2a Local Transport - Car Parking Provisions
IEQ11b Localized Ventilation - Local exhaust
EU1 Reduce annual kWh consumption
WU4a Water Recycling - Harvested Rainwater
MA7b Recycled Materials - Building Structure
IEQ15 Natural lighting
IEQ13b Thermal Comfort in AC Premises - Room air distribution
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score



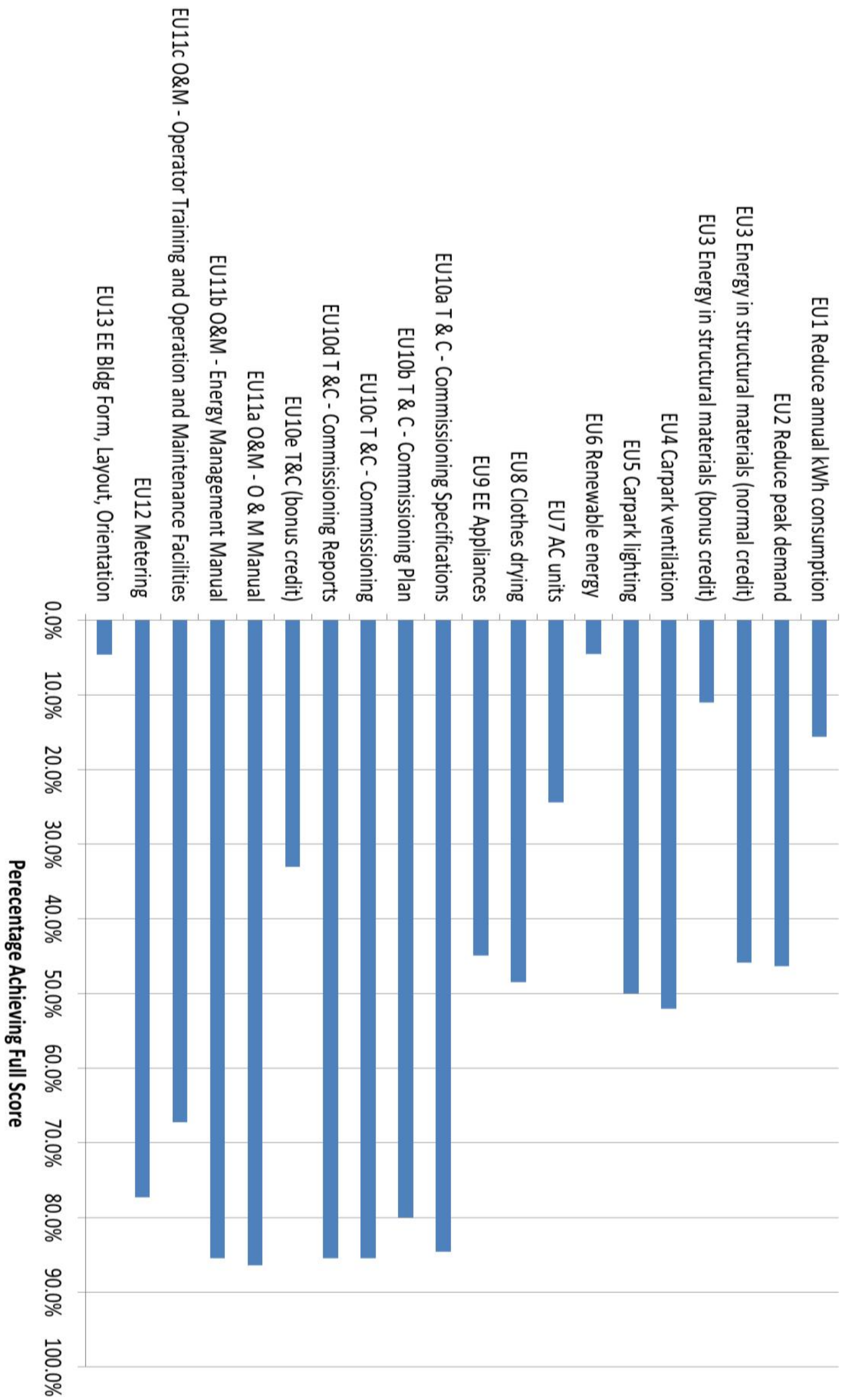
MA11 Construction waste recycle
SA6 Cultural heritage
EU3 Energy in structural materials (bonus credit)
WU4c Water Recycling - A Combination (bonus credit)
MA1 Bldg reuse (normal credits)
IEQ12b Common area ventilation (bonus credit)
MA1 Bldg reuse (bonus credit)
EU13 EE Bldg Form, Layout, Orientation
EU6 Renewable energy
MA3 Prefab
WU2 Leak monitor for exposed pipes
MA7c Recycled Materials - Interior Building Component
IEQ19 Noise isolation between rooms (bonus credit)
SA8b Microclimate - Elevated Temperatures
WU4b Water Recycling - Recycled Water
IA1 + IA2 Innovative Techniques & Performance Enhancements
IA1 Innovative Techniques
IA2 Performance Enhancements
MA5 Rapid Renewable Mtl
SA1 Contaminated land
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

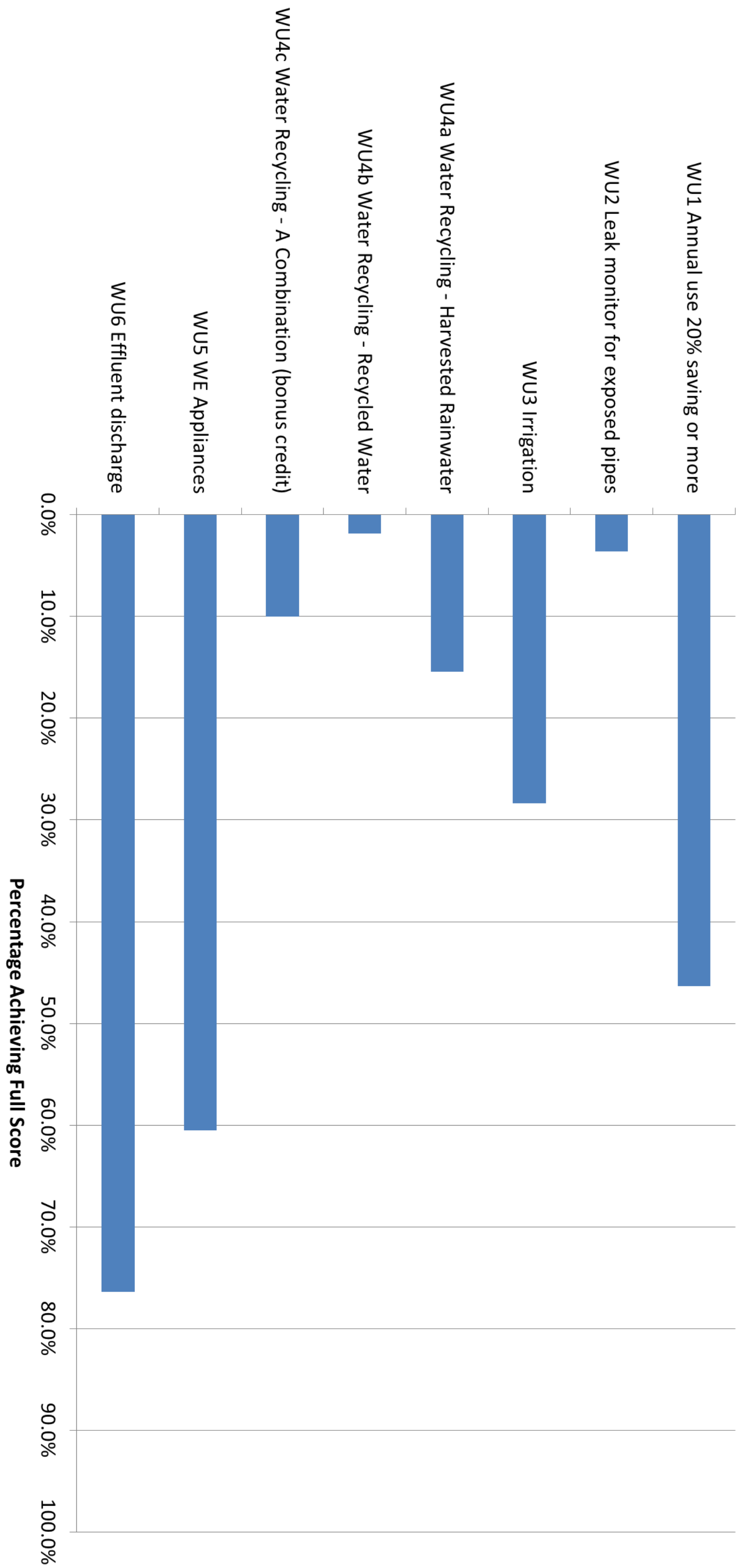
Appendix H: Achievement of All Credits (Credit Order)

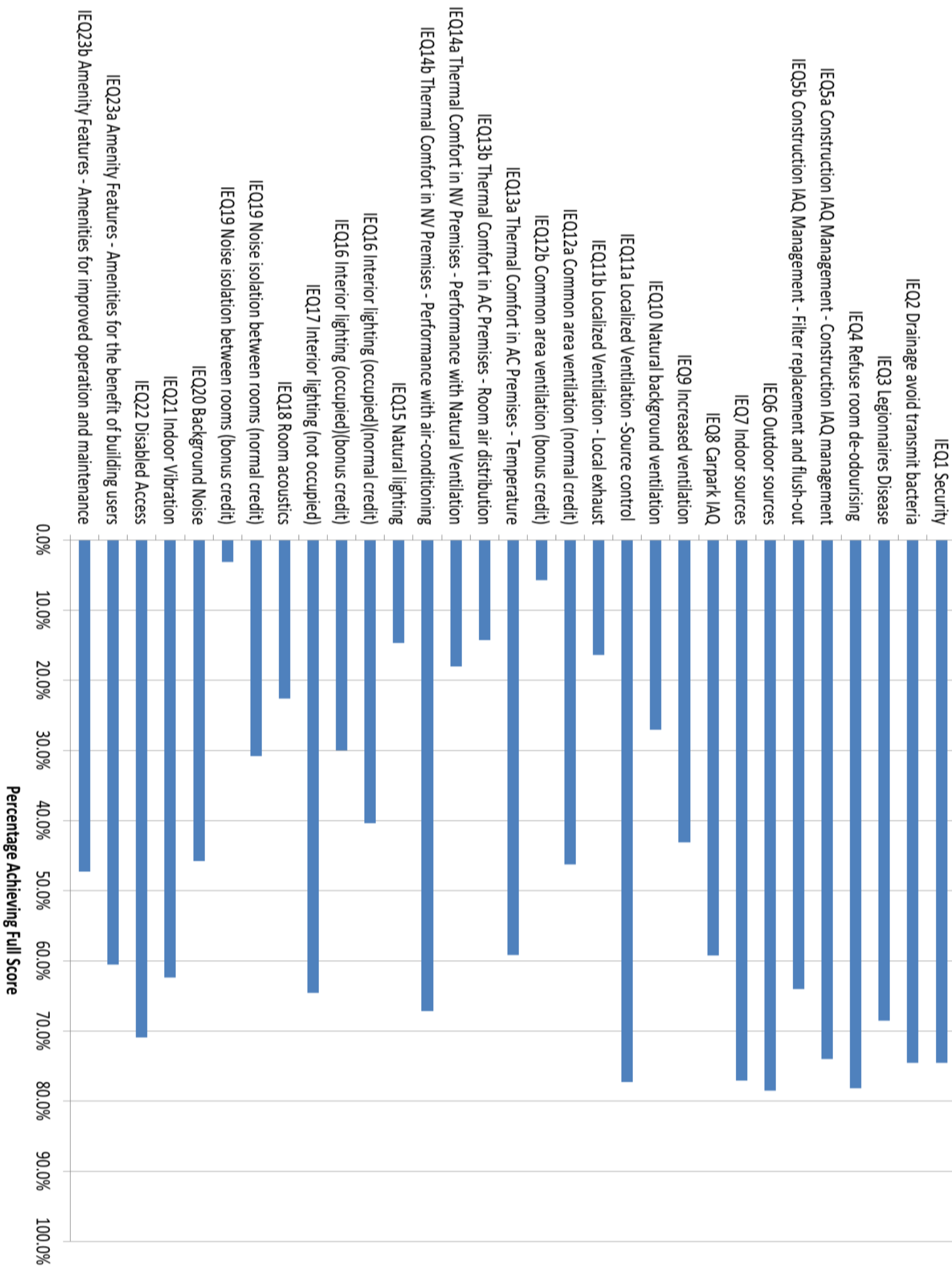


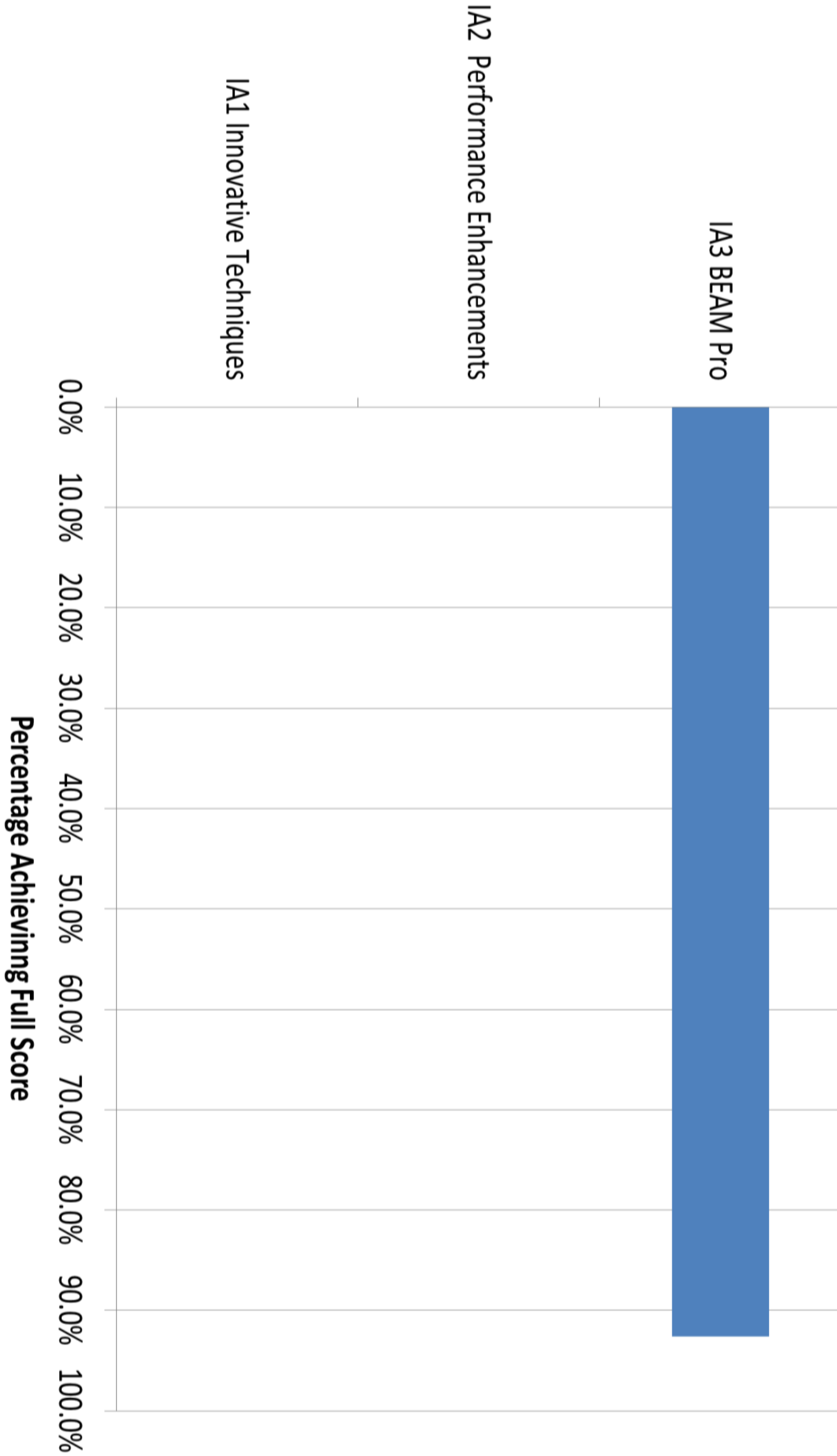


MA1 Bldg reuse (normal credits)
MA1 Bldg reuse (bonus credit)
MA2 Modular / Standardized design
MA3 Prefab
MA4a Adaptability of Deconstruction - Flexible Engineering Services
MA4b Adaptability of Deconstruction - Flexible Engineering Services
MA4c Adaptability of Deconstruction - Structural Adaptability
MA5 Rapid Renewable Mtl
MA6 FSC Products
MA7a Recycled Materials - Surface Works and Structures
MA7b Recycled Materials - Building Structure
MA7c Recycled Materials - Interior Building Component
MA8a Ozone Depleting Substances - Refrigerants
MA8b Ozone Depleting Substances - Ozone Depleting Materials
MA9 Regional materials
MA10 Demolition waste
MA11 Construction waste recycle
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

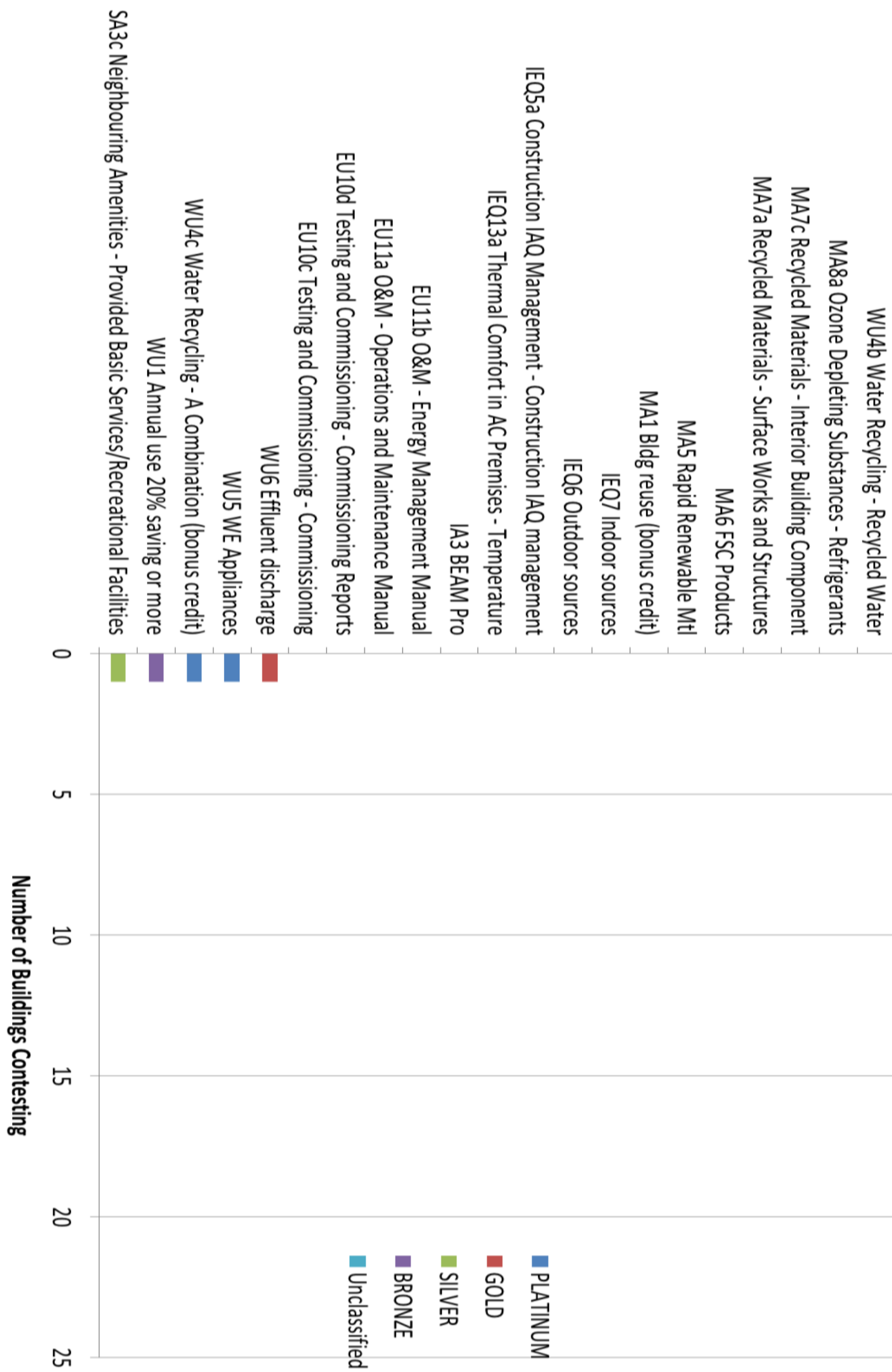

EU1 Reduce annual kWh consumption
EU2 Reduce peak demand
EU3 Energy in structural materials (normal credit)
EU3 Energy in structural materials (bonus credit)
EU4 Carpark ventilation
EU5 Carpark lighting
EU6 Renewable energy
EU7 AC units
EU8 Clothes drying
EU9 EE Appliances
EU10a T & C - Commissioning Specifications
EU10b T & C - Commissioning Plan
EU10c T &C - Commissioning
EU10d T &C - Commissioning Reports
EU10e T&C (bonus credit)
EU11a O&M - O & M Manual
EU11b O&M - Energy Management Manual
EU11c O&M - Operator Training and Operation and Maintenance Facilities
EU12 Metering
EU13 EE Bldg Form, Layout, Orientation
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Perecentage Achieving Full Score

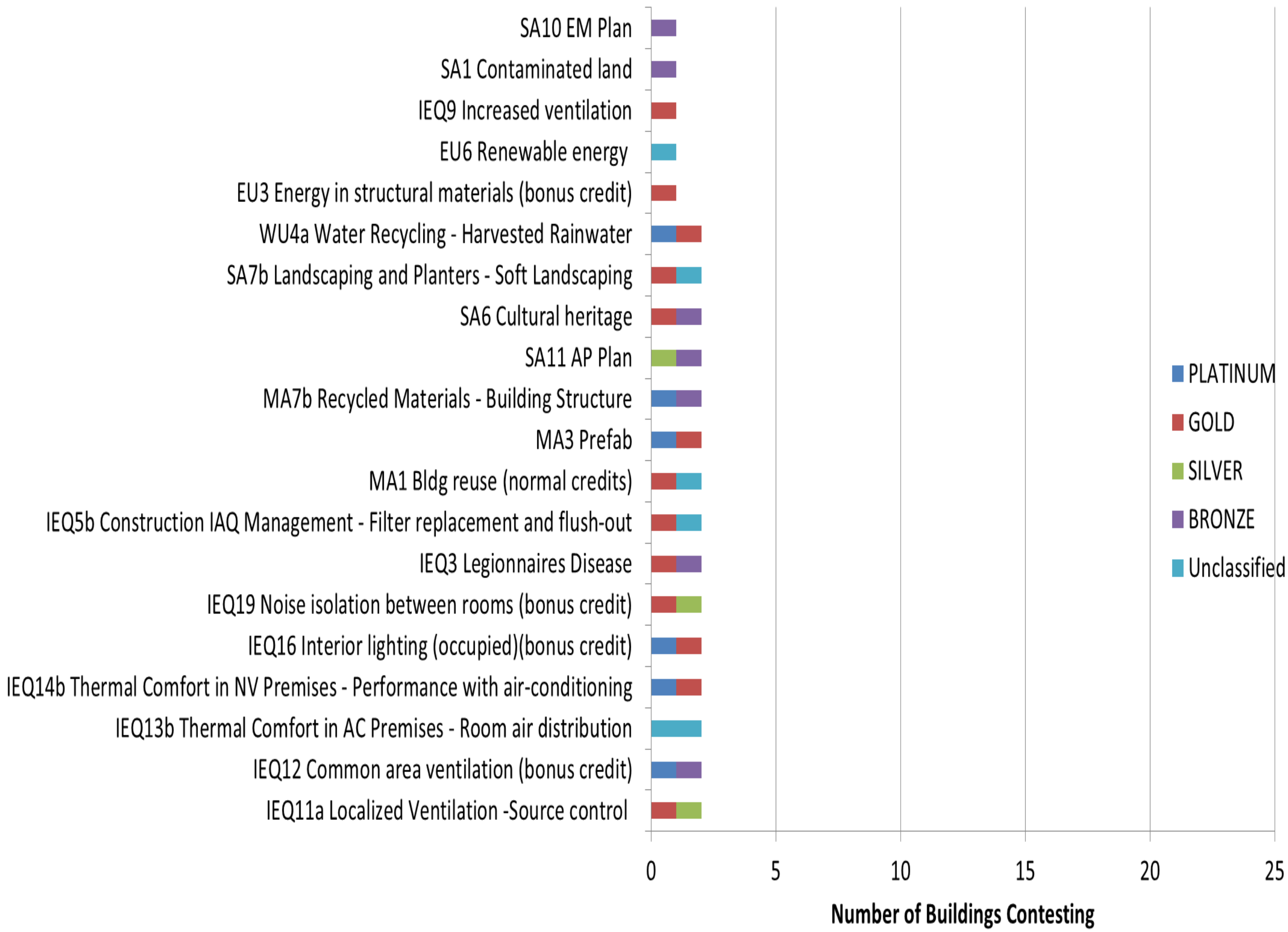

WU1 Annual use 20% saving or more
WU2 Leak monitor for exposed pipes
WU3 Irrigation
WU4a Water Recycling - Harvested Rainwater
WU4b Water Recycling - Recycled Water
WU4c Water Recycling - A Combination (bonus credit)
WU5 WE Appliances
WU6 Effluent discharge
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

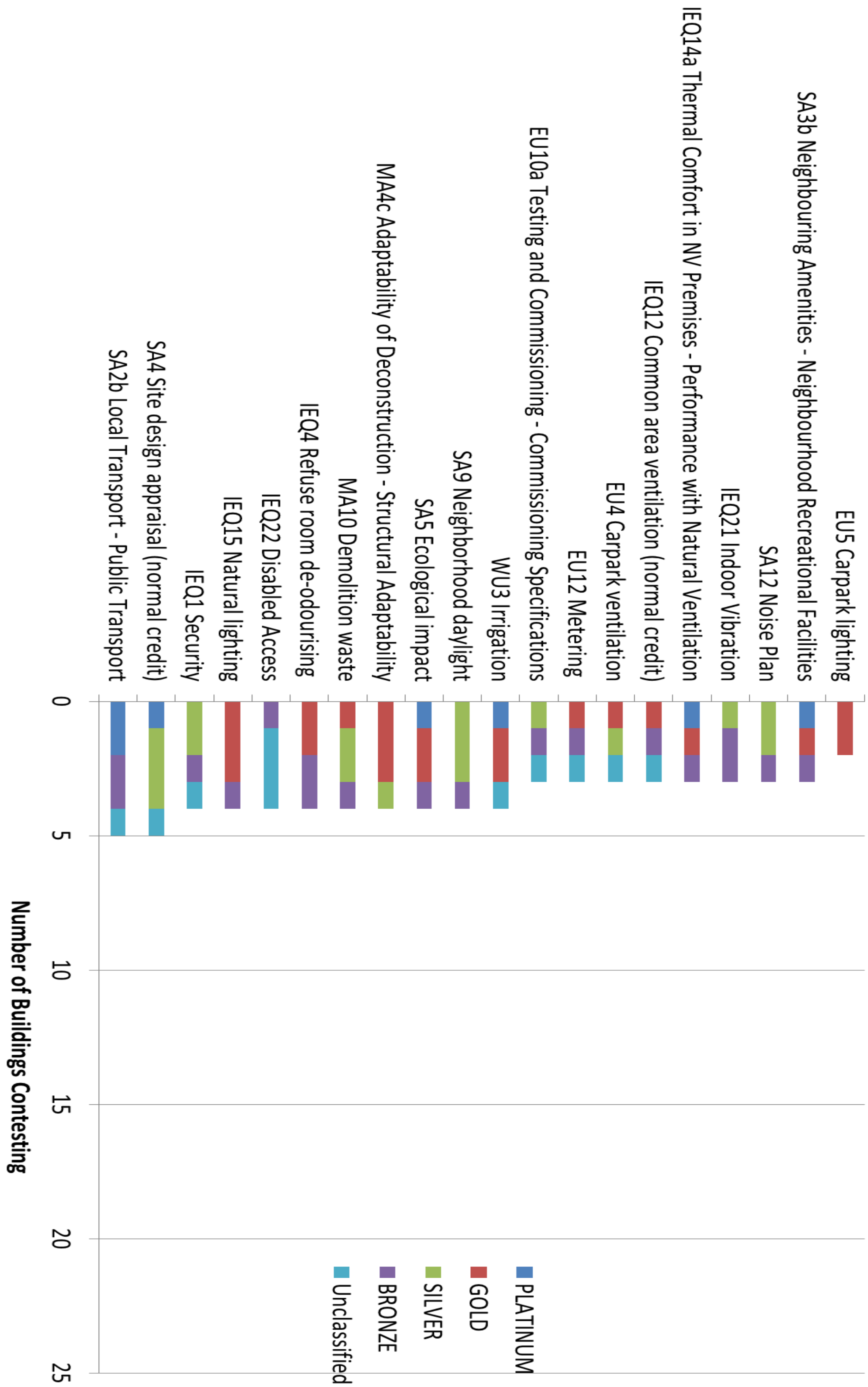

IEQ1 Security
IEQ2 Drainage avoid transmit bacteria
IEQ3 Legionnaires Disease
IEQ4 Refuse room de-odourising
IEQ5a Construction IAQ Management - Construction IAQ management
IEQ5b Construction IAQ Management - Filter replacement and flush-out
IEQ6 Outdoor sources
IEQ7 Indoor sources
IEQ8 Carpark IAQ
IEQ9 Increased ventilation
IEQ10 Natural background ventilation
IEQ11a Localized Ventilation -Source control
IEQ11b Localized Ventilation - Local exhaust
IEQ12a Common area ventilation (normal credit)
IEQ12b Common area ventilation (bonus credit)
IEQ13a Thermal Comfort in AC Premises - Temperature
IEQ13b Thermal Comfort in AC Premises - Room air distribution
IEQ14a Thermal Comfort in NV Premises - Performance with Natural Ventilation
IEQ14b Thermal Comfort in NV Premises - Performance with air-conditioning
IEQ15 Natural lighting
IEQ16 Interior lighting (occupied)(normal credit)
IEQ16 Interior lighting (occupied)(bonus credit)
IEQ17 Interior lighting (not occupied)
IEQ18 Room acoustics
IEQ19 Noise isolation between rooms (normal credit)
IEQ19 Noise isolation between rooms (bonus credit)
IEQ20 Background Noise
IEQ21 Indoor Vibration
IEQ22 Disabled Access
IEQ23a Amenity Features - Amenities for the benefit of building users
IEQ23b Amenity Features - Amenities for improved operation and maintenance
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

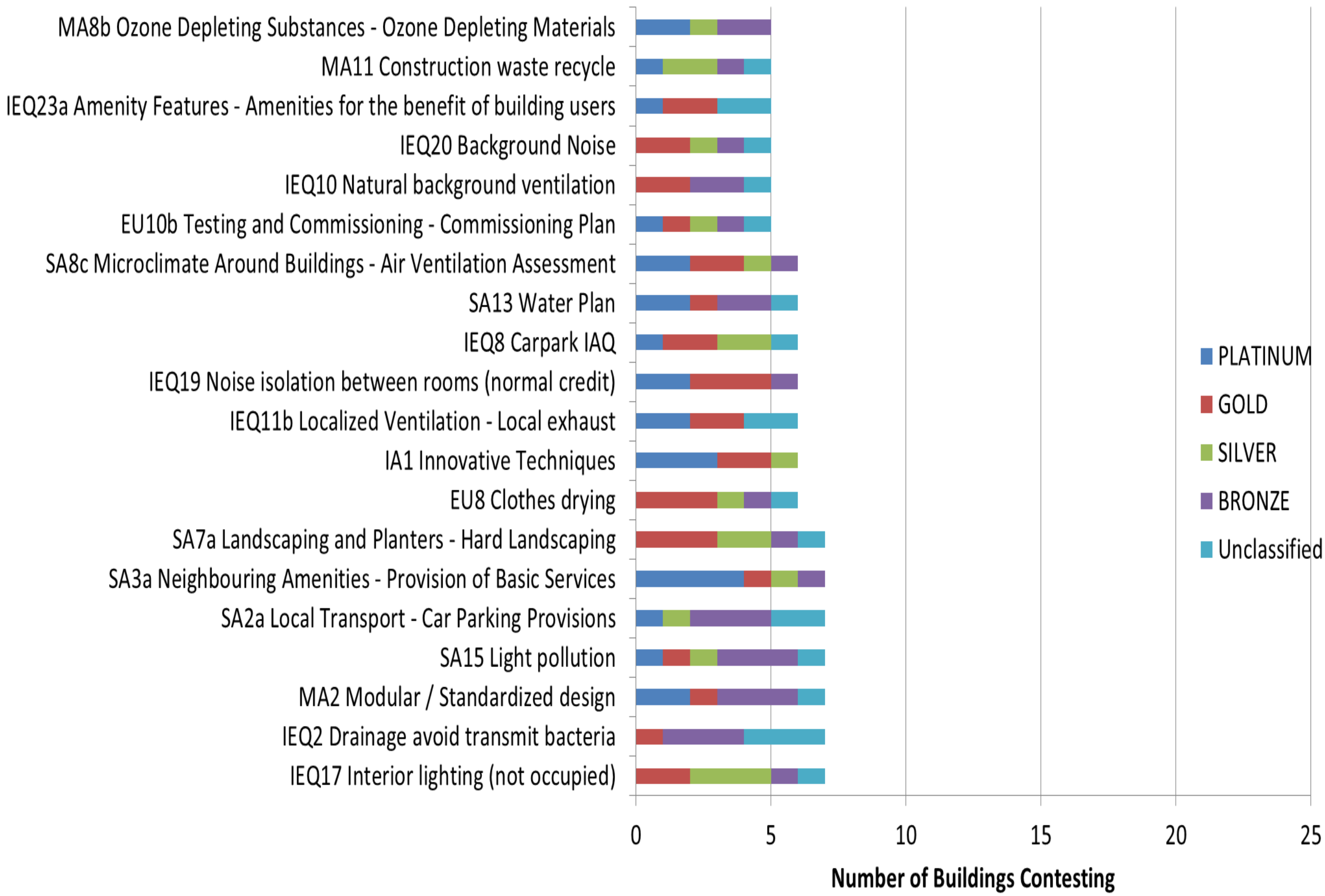

IA1 Innovative Techniques
IA2 Performance Enhancements
IA3 BEAM Pro
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Percentage Achieving Full Score

Appendix I: Number of Projects Contesting Credits (Contesting Order)

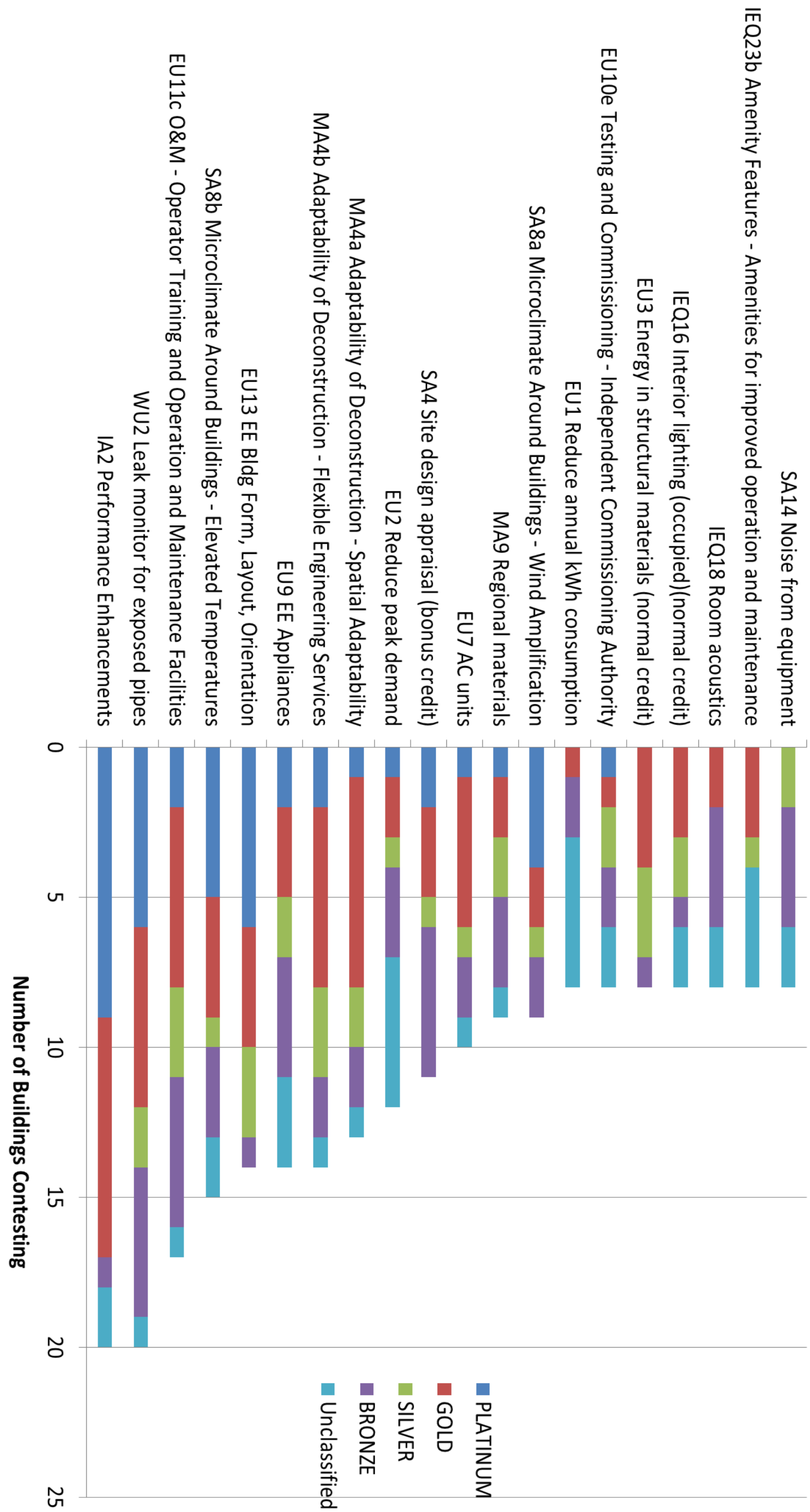



SA10 EM Plan
SA1 Contaminated land
IEQ9 Increased ventilation
EU6 Renewable energy
EU3 Energy in structural materials (bonus credit)
WU4a Water Recycling - Harvested Rainwater
SA7b Landscaping and Planters - Soft Landscaping
SA6 Cultural heritage
SA11 AP Plan
MA7b Recycled Materials - Building Structure
MA3 Prefab
MA1 Bldg reuse (normal credits)
IEQ5b Construction IAQ Management - Filter replacement and flush-out
IEQ3 Legionnaires Disease
IEQ19 Noise isolation between rooms (bonus credit)
IEQ16 Interior lighting (occupied)(bonus credit)
IEQ14b Thermal Comfort in NV Premises - Performance with air-conditioning
IEQ13b Thermal Comfort in AC Premises - Room air distribution
IEQ12 Common area ventilation (bonus credit)
IEQ11a Localized Ventilation -Source control
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified

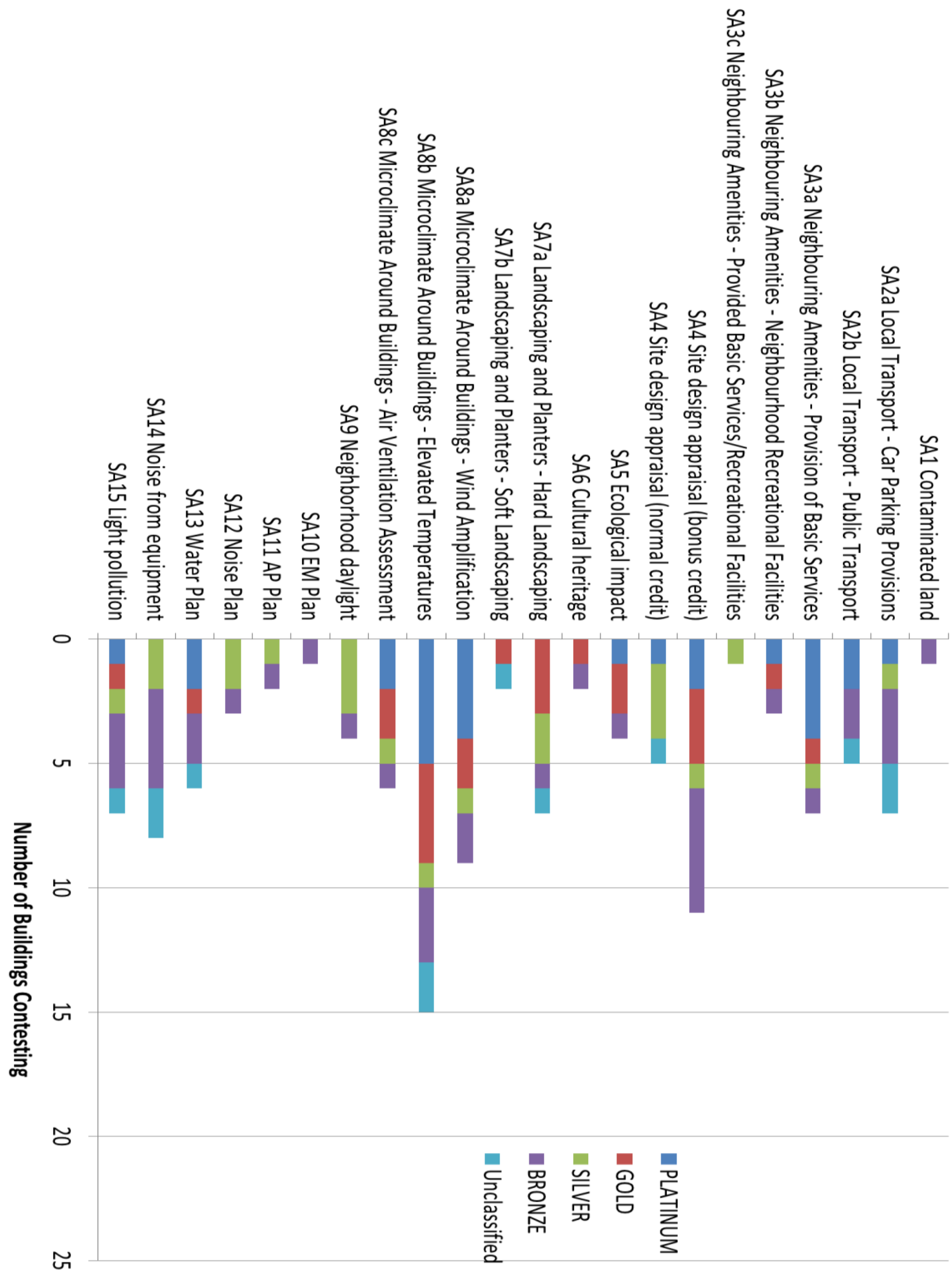

EU5 Carpark lighting
SA3b Neighbouring Amenities - Neighbourhood Recreational Facilities
SA12 Noise Plan
IEQ21 Indoor Vibration
IEQ14a Thermal Comfort in NV Premises - Performance with Natural Ventilation
IEQ12 Common area ventilation (normal credit)
EU4 Carpark ventilation
EU12 Metering
EU10a Testing and Commissioning - Commissioning Specifications
WU3 Irrigation
SA9 Neighborhood daylight
SA5 Ecological impact
MA4c Adaptability of Deconstruction - Structural Adaptability
MA10 Demolition waste
IEQ4 Refuse room de-odourising
IEQ22 Disabled Access
IEQ15 Natural lighting
IEQ1 Security
SA4 Site design appraisal (normal credit)
SA2b Local Transport - Public Transport
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified

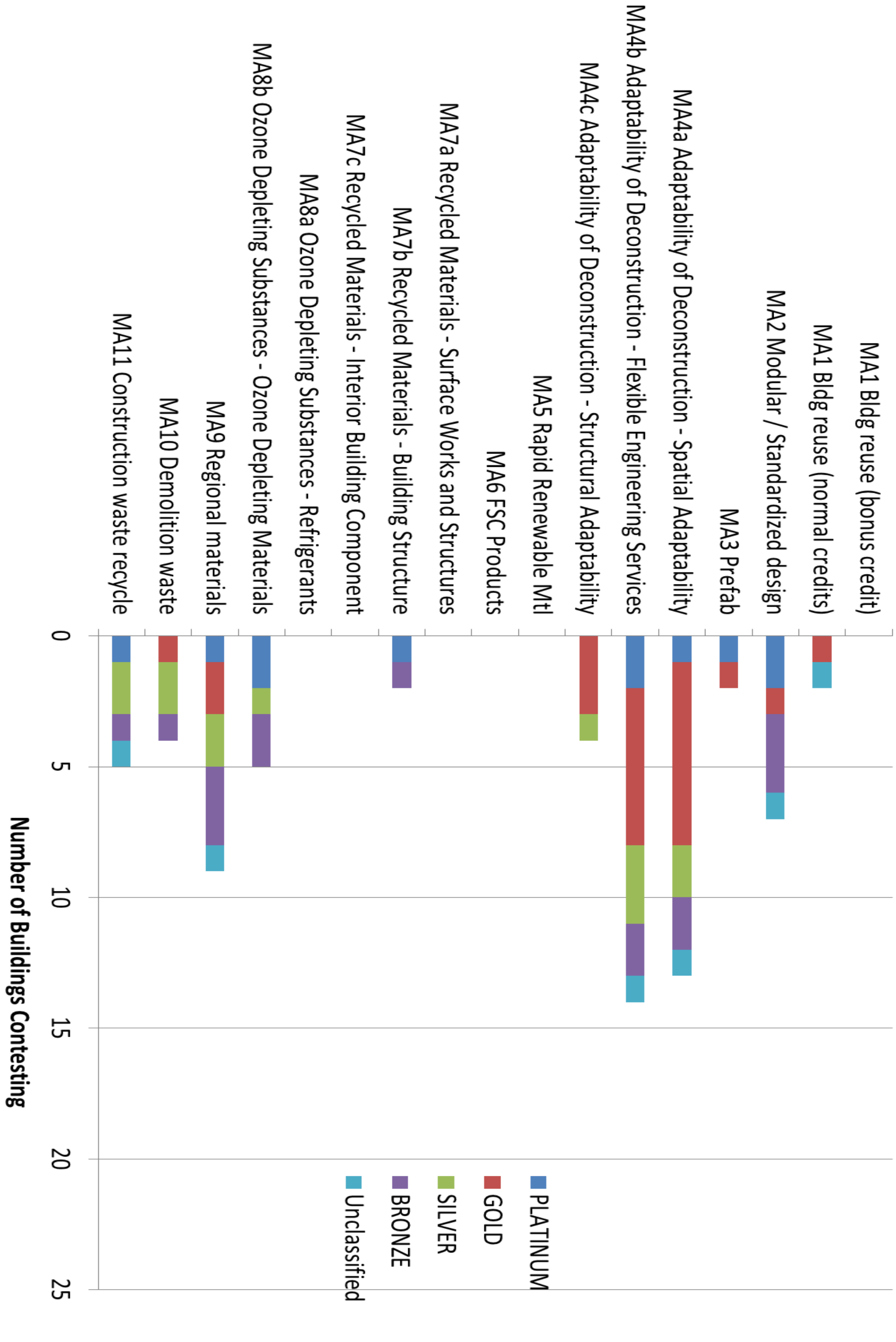


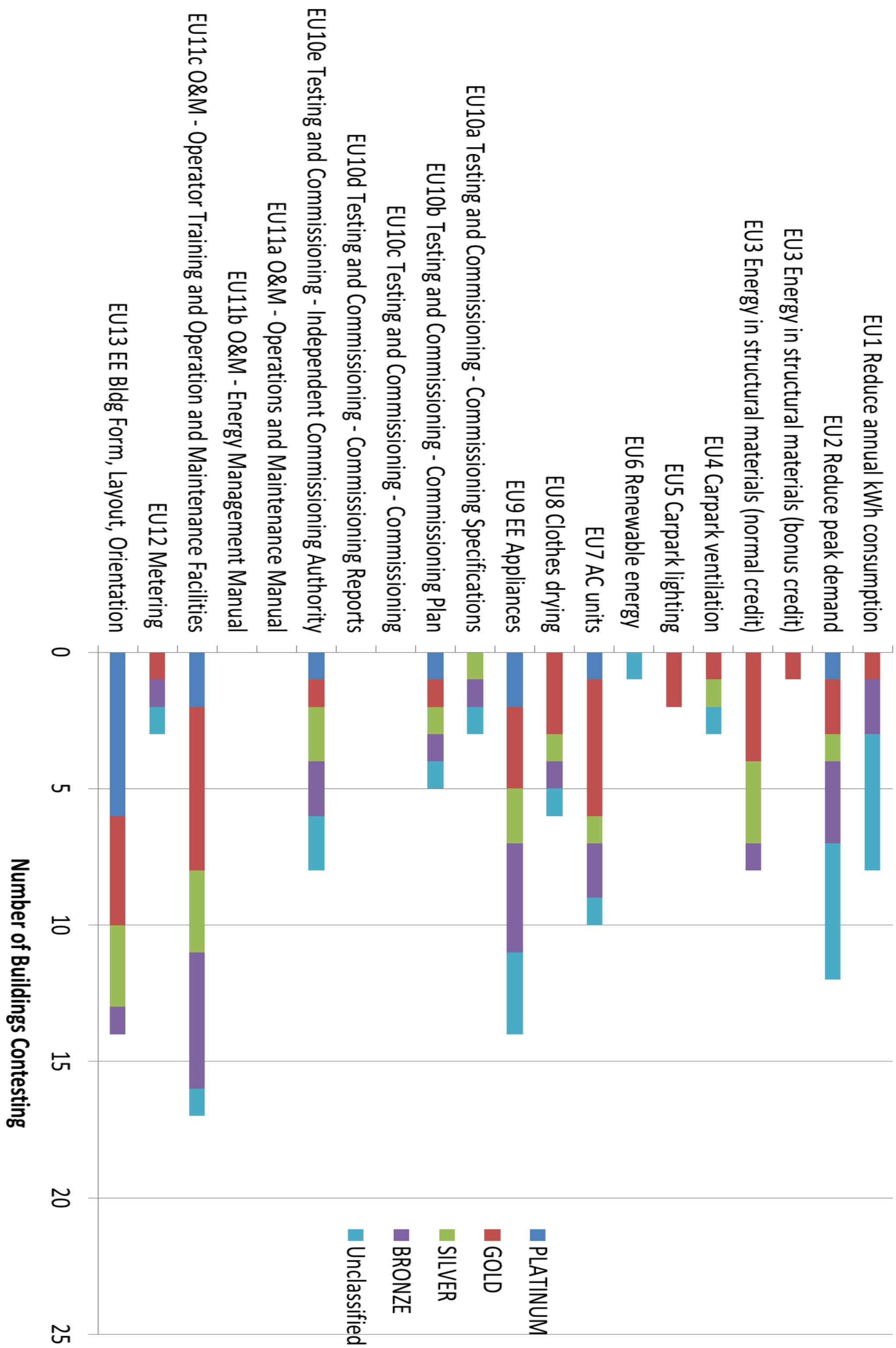
MA8b Ozone Depleting Substances - Ozone Depleting Materials
MA11 Construction waste recycle
IEQ23a Amenity Features - Amenities for the benefit of building users
IEQ20 Background Noise
IEQ10 Natural background ventilation
EU10b Testing and Commissioning - Commissioning Plan
SA8c Microclimate Around Buildings - Air Ventilation Assessment
SA13 Water Plan
IEQ8 Carpark IAQ
IEQ19 Noise isolation between rooms (normal credit)
IEQ11b Localized Ventilation - Local exhaust
IA1 Innovative Techniques
EU8 Clothes drying
SA7a Landscaping and Planters - Hard Landscaping
SA3a Neighbouring Amenities - Provision of Basic Services
SA2a Local Transport - Car Parking Provisions
SA15 Light pollution
MA2 Modular / Standardized design
IEQ2 Drainage avoid transmit bacteria
IEQ17 Interior lighting (not occupied)
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified

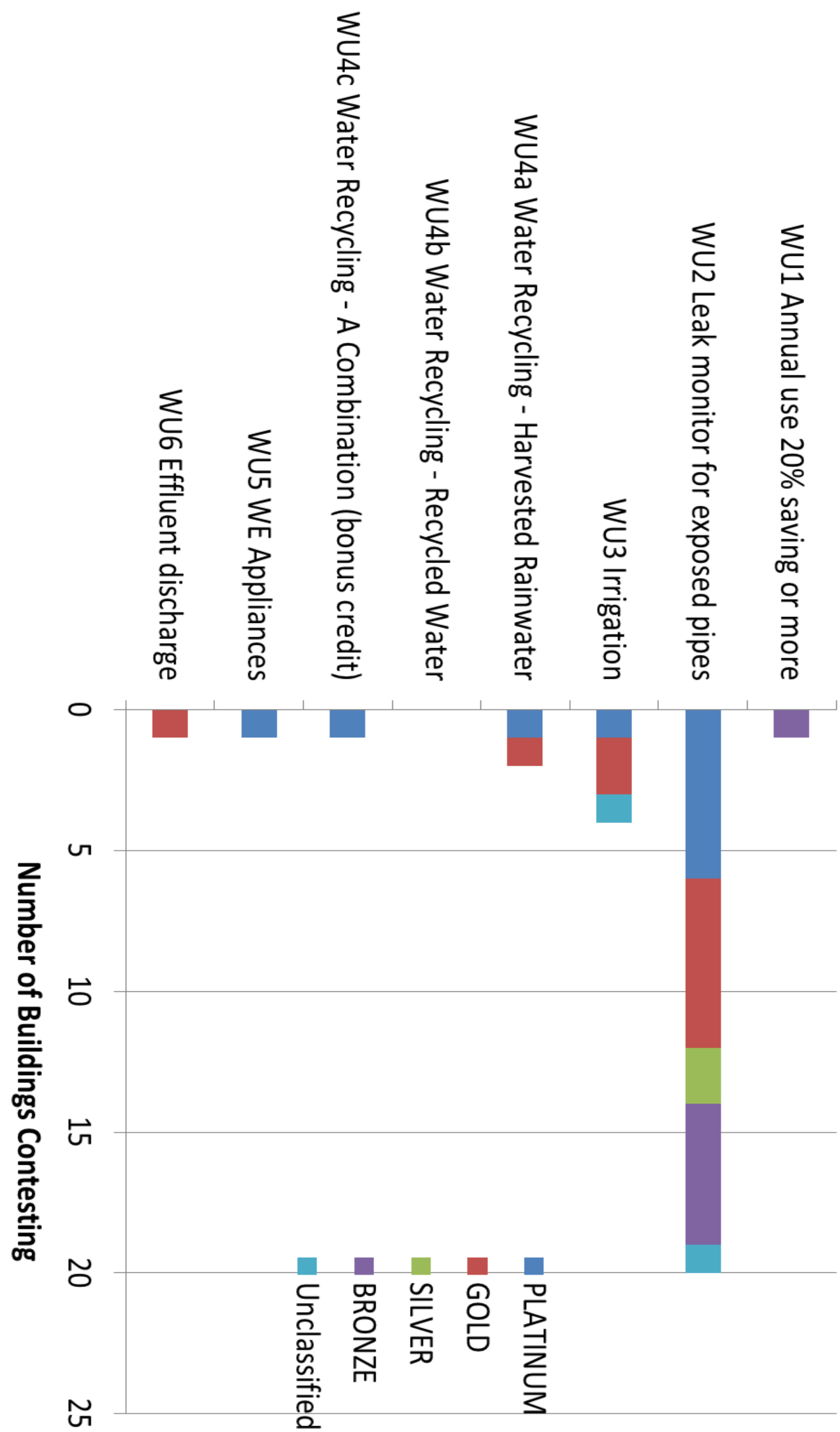

SA14 Noise from equipment
IEQ23b Amenity Features - Amenities for improved operation and maintenance
IEQ18 Room acoustics
IEQ16 Interior lighting (occupied)(normal credit)
EU3 Energy in structural materials (normal credit)
EU10e Testing and Commissioning - Independent Commissioning Authority
EU1 Reduce annual kWh consumption
SA8a Microclimate Around Buildings - Wind Amplification
MA9 Regional materials
EU7 AC units
SA4 Site design appraisal (bonus credit)
EU2 Reduce peak demand
MA4a Adaptability of Deconstruction - Spatial Adaptability
MA4b Adaptability of Deconstruction - Flexible Engineering Services
EU9 EE Appliances
EU13 EE Bldg Form, Layout, Orientation
SA8b Microclimate Around Buildings - Elevated Temperatures
EU11c O&M - Operator Training and Operation and Maintenance Facilities
WU2 Leak monitor for exposed pipes
IA2 Performance Enhancements
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified

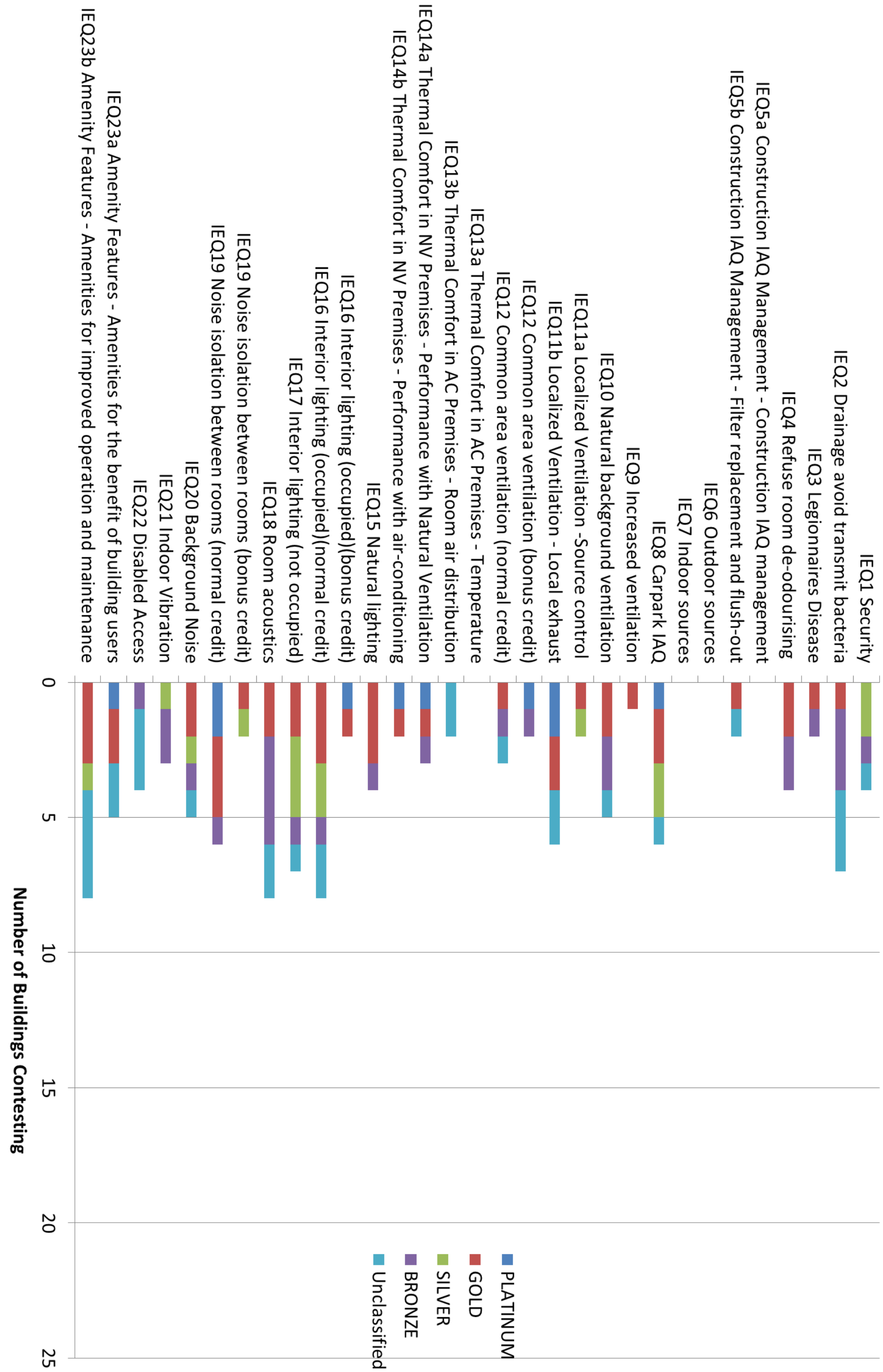
Appendix J: Number of Projects Contesting Credits (Credit Order)



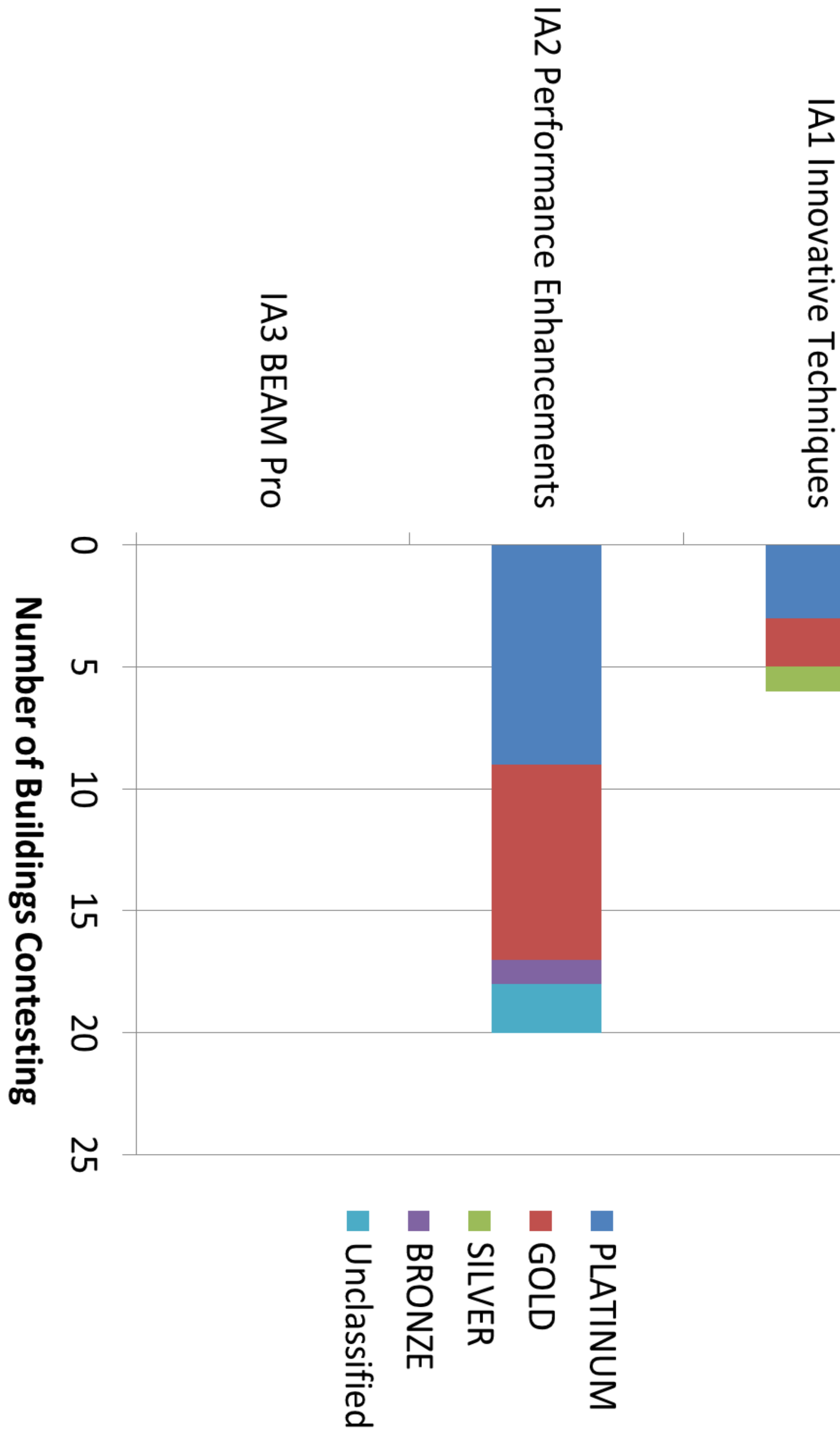

MA1 Bldg reuse (bonus credit)
MA1 Bldg reuse (normal credits)
MA2 Modular / Standardized design
MA3 Prefab
MA4a Adaptability of Deconstruction - Spatial Adaptability
MA4b Adaptability of Deconstruction - Flexible Engineering Services
MA4c Adaptability of Deconstruction - Structural Adaptability
MA5 Rapid Renewable Mtl
MA6 FSC Products
MA7a Recycled Materials - Surface Works and Structures
MA7b Recycled Materials - Building Structure
MA7c Recycled Materials - Interior Building Component
MA8a Ozone Depleting Substances - Refrigerants
MA8b Ozone Depleting Substances - Ozone Depleting Materials
MA9 Regional materials
MA10 Demolition waste
MA11 Construction waste recycle
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified


EU1 Reduce annual kWh consumption
EU2 Reduce peak demand
EU3 Energy in structural materials (bonus credit)
EU3 Energy in structural materials (normal credit)
EU4 Carpark ventilation
EU5 Carpark lighting
EU6 Renewable energy
EU7 AC units
EU8 Clothes drying
EU9 EE Appliances
EU10a Testing and Commissioning - Commissioning Specifications
EU10b Testing and Commissioning - Commissioning Plan
EU10c Testing and Commissioning - Commissioning
EU10d Testing and Commissioning - Commissioning Reports
EU10e Testing and Commissioning - Independent Commissioning Authority
EU11a O&M - Operations and Maintenance Manual
EU11b O&M - Energy Management Manual
EU11c O&M - Operator Training and Operation and Maintenance Facilities
EU12 Metering
EU13 EE Bldg Form, Layout, Orientation
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified


WU1 Annual use 20% saving or more
WU2 Leak monitor for exposed pipes
WU3 Irrigation
WU4a Water Recycling - Harvested Rainwater
WU4b Water Recycling - Recycled Water
WU4c Water Recycling - A Combination (bonus credit)
WU5 WE Appliances
WU6 Effluent discharge
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified



IEQ1 Security
IEQ2 Drainage avoid transmit bacteria
IEQ3 Legionnaires Disease
IEQ4 Refuse room de-odourising
IEQ5a Construction IAQ Management - Construction IAQ management
IEQ5b Construction IAQ Management - Filter replacement and flush-out
IEQ6 Outdoor sources
IEQ7 Indoor sources
IEQ8 Carpark IAQ
IEQ9 Increased ventilation
IEQ10 Natural background ventilation
IEQ11a Localized Ventilation -Source control
IEQ11b Localized Ventilation - Local exhaust
IEQ12 Common area ventilation (bonus credit)
IEQ12 Common area ventilation (normal credit)
IEQ13a Thermal Comfort in AC Premises - Temperature
IEQ13b Thermal Comfort in AC Premises - Room air distribution
IEQ14a Thermal Comfort in NV Premises - Performance with Natural Ventilation
IEQ14b Thermal Comfort in NV Premises - Performance with air-conditioning
IEQ15 Natural lighting
IEQ16 Interior lighting (occupied)(bonus credit)
IEQ16 Interior lighting (occupied)(normal credit)
IEQ17 Interior lighting (not occupied)
IEQ18 Room acoustics
IEQ19 Noise isolation between rooms (bonus credit)
IEQ19 Noise isolation between rooms (normal credit)
IEQ20 Background Noise
IEQ21 Indoor Vibration
IEQ22 Disabled Access
IEQ23a Amenity Features - Amenities for the benefit of building users
IEQ23b Amenity Features - Amenities for improved operation and maintenance
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified


IA1 Innovative Techniques
IA2 Performance Enhancements
IA3 BEAM Pro
0
5
10
15
20
25
Number of Buildings Contesting
PLATINUM
GOLD
SILVER
BRONZE
Unclassified

Appendix K: Site Visit Results for Building A

1. How would you rate the success of green technologies in your building?

Respondent: I am very satisfied with the green technologies in the building.

2. What was your reason for getting your building BEAM Plus certified?

Respondent: I did it to set an example for temporary offices for the future.

3. Do you think it was worth the extra effort to get your building BEAM Plus certified?

Respondent: I think it was worth it.

4. What sort of feedback have you received from occupant/ operators about green technologies?

Respondent: The staff is very pleased with the green technologies. It is a simple operable building.

5. How are the following technologies working?

a. Natural Ventilation

Respondent: It's used about 10% of the year.

b. Acoustics

Respondent: There is not much noise from the overpass above the building, just some from the temporary construction near the office.

Appendix L: Site Visit Results for Building B

1. How would you rate the success of green technologies in your building?

Respondent: It works well, as designed.

2. What was your reason for getting your building BEAM certified?

Respondent: There was no real incentive. We just want to try and do better in more areas than just zero carbon buildings, and getting BEAM Plus certified was a way to do it.

3. Are the following technologies working as planned?

a. Photoval on roof

Respondent: It is producing more electricity than was originally planned

b. Biofuel

Respondent: It has not been up to standard

c. Conventional chillers?

Respondent: Trying to use the conventional chillers and the other chillers into one system does not work. They are now working in parallel.

d. Any other issues?

Respondent: Insects are a huge issue. There are mosquito traps in place for now, but we are looking to get a mosquito screen. We have not yet achieved desired goal of producing more than consuming. They are still trying to hit it though. W.C. has changed from the report because of a privacy issue. Instead of having open space in the top and bottom for helping ventilation there is now no space between the partitions and the ceiling.

5. Other comments for BEAM Plus?

Respondent: We would like BEAM Plus to promote low carbon construction.

Appendix M: Site Visit Results for Building C

1. How would you rate the success of the green technologies in your building?

Respondent: They are very successful, but not always reliable.

2. Are the following technologies working as planned/ have there been any problems encountered with:

a. Chilled headboards

Respondent: Only two are installed in rooms right now. It’s a new thing, so we want to make sure that the occupant’s comfort is top priority.

b. Vertical greening

Respondent: Every six months maybe 5% of the plants have to be replaced, so they are generally healthy.

3. Do you have other comments about BEAM Plus or other green technologies?

Respondent: We can go further with energy savings. Also, it might be a good idea to monitor the performance of buildings on a long-term scale. The Innovative Aspects credits are difficult to achieve; the definition is not really clear.

Appendix N: Site Visit Results for Building D

Interview with Tenant

1. Did this building being BEAM Plus certified impact your choice in being here?

Respondent: yes

2. Do you or your staff have any inconveniences because of the green technology?

Respondent: No, the staff just needs to get used to the technologies, such as the light sensors and the natural lighting. For some it's too bright in the evening.

3. How is the following technology working?

a. Natural Ventilation

Respondent: right now, it's only on for the normal working day, so it's on from maybe 8am to 8pm Monday through Friday. It can be turned on during the weekend if they ask the building staff, but not every staff member knows that. More noise also comes in when using the natural ventilation.

4. General comments about BEAM Plus?

Respondent: Lack of materials with energy labels in Hong Kong. Want more choices of equipment. It's also hard to understand and work with the green certification being new. We have to rely on the consultant.

Interview with Building Team (6 respondents)

1. Why did you choose to get your building BEAM Plus certified?

Respondent 1: We intended to build a building that can benefit us and the environment

Respondent 2: We were already LEED certified, but we wanted out building to locally relevant too.

2. How would rate the success of your technology?

Respondent 3: very good.

Respondent 2: Our EUI (Energy Usage Index) is the lowest among other shopping malls in Hong Kong.

3. Any specific technology that is contributing to the low EUI?

Respondent 2: No, we think the thing that is contributing the most is the awareness of the staff wanting to keep energy usage low. It starts with the operators, and then trickles down to the tenants and occupants.

4. How are the following technologies working?

a. Natural ventilation

Respondent 2: It was used most of January. It is not used in the summer, but that was not the intended function of it.

Respondent 4: The tenants enjoy it, and there's not much significant impact by noise. The climate is actually the main factor in its use. It gets used maybe 5 months out of the year, from September to May.

b. Urban Window

Respondent 2: The 'Urban Window' is basically a huge hole in the middle of the building, and it helps to flush out pollution in front of the building.

c. Wetlands on the 16th floor.

Respondent 2: They were not part of the original plan, but we use it to recycle greywater from the 15 floors below it.

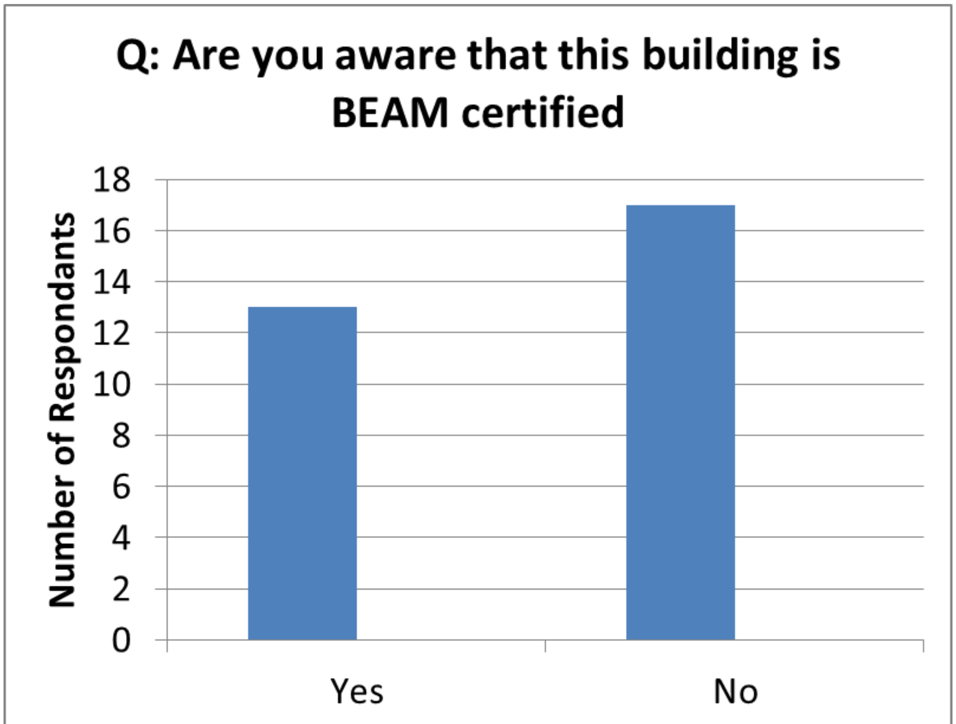
d. Roof farm

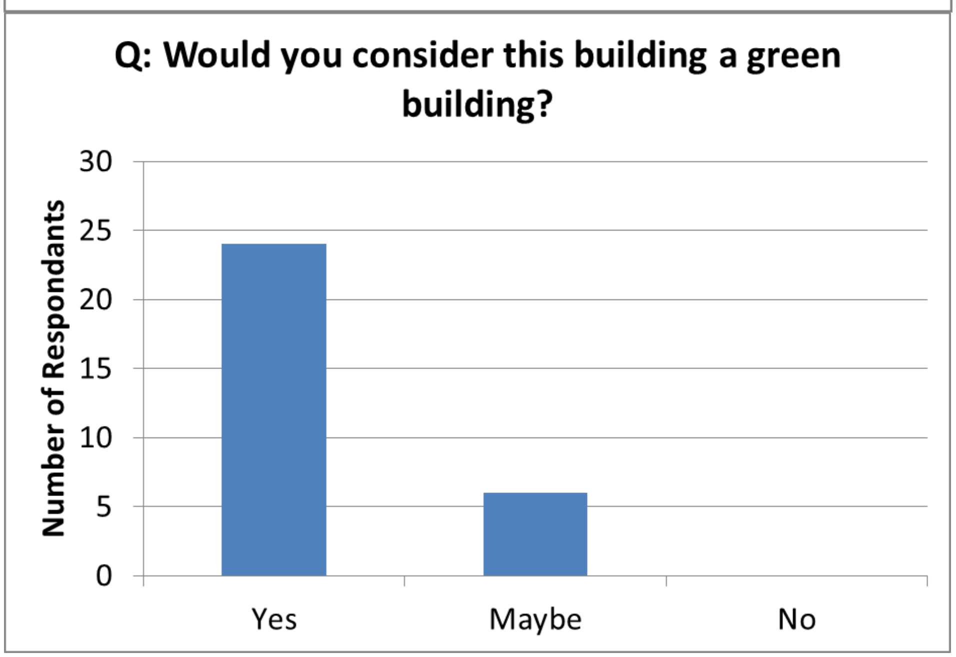
Respondent 2: It was originally designed as a green roof. Now it's open 2-3 times a week for schools and tenants. The rest of the time NGO's use it.

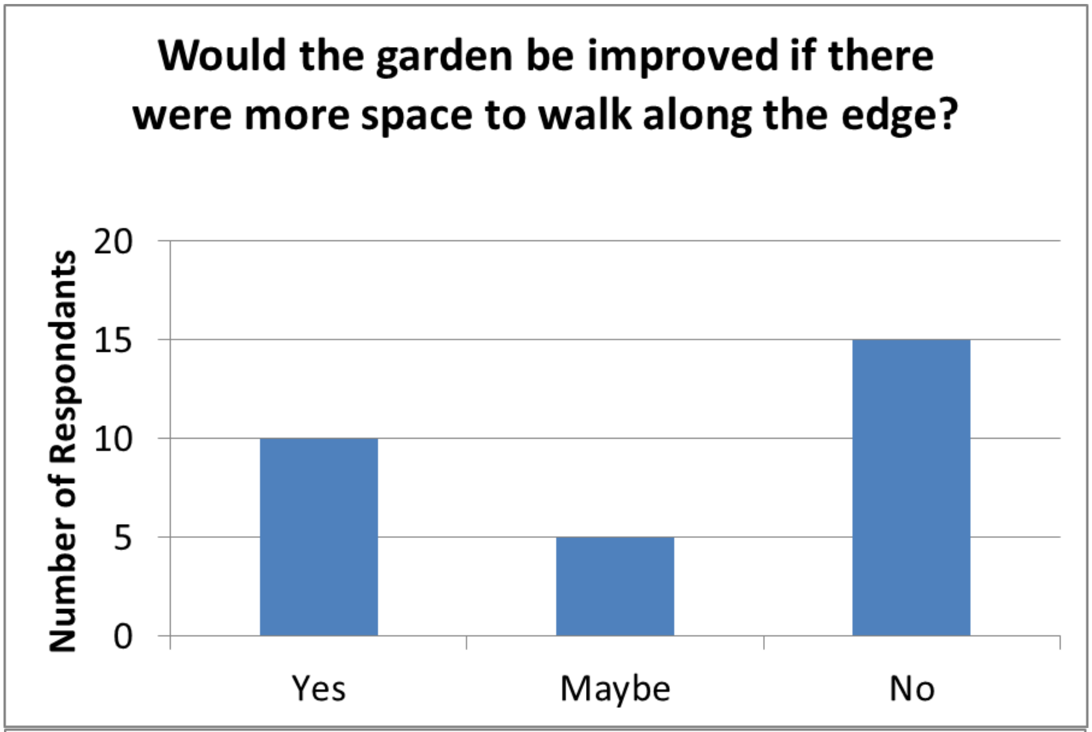
5. General comments on BEAM Plus or green technology?

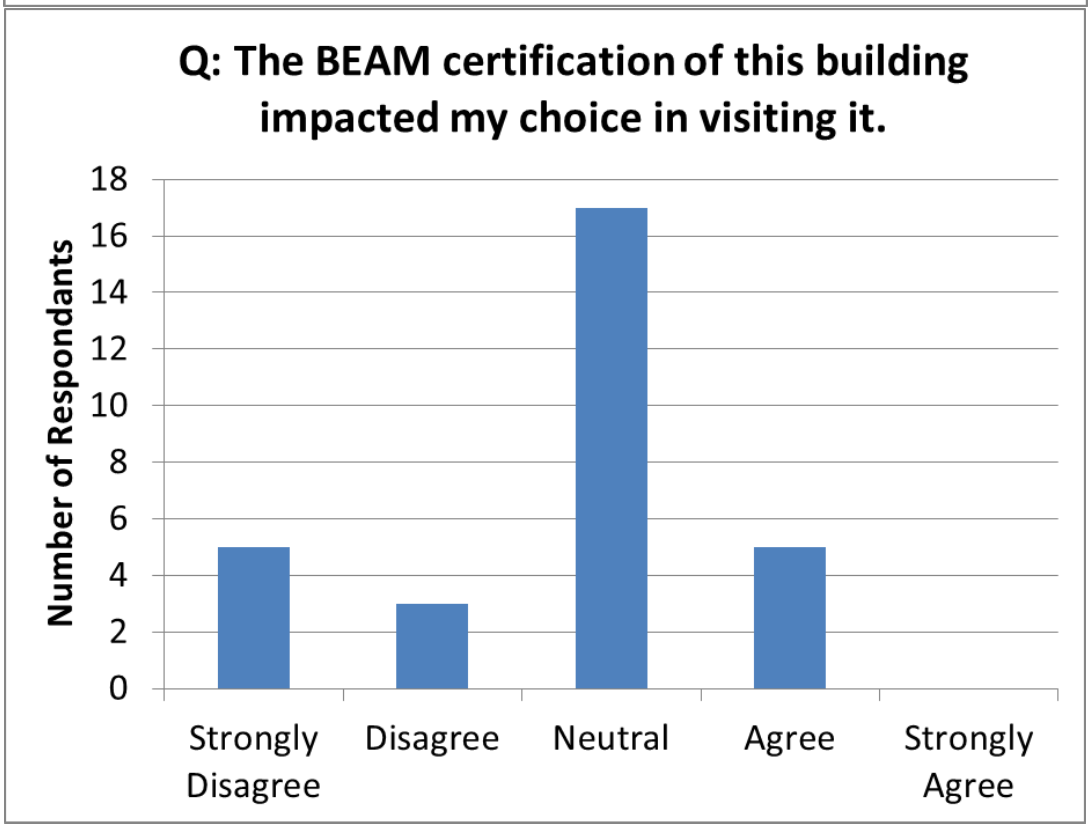
Respondent 2: We would like to try and make whole areas more sustainable. Not exactly sure how yet though. We would like our area to be good financially, environmentally, and socially.

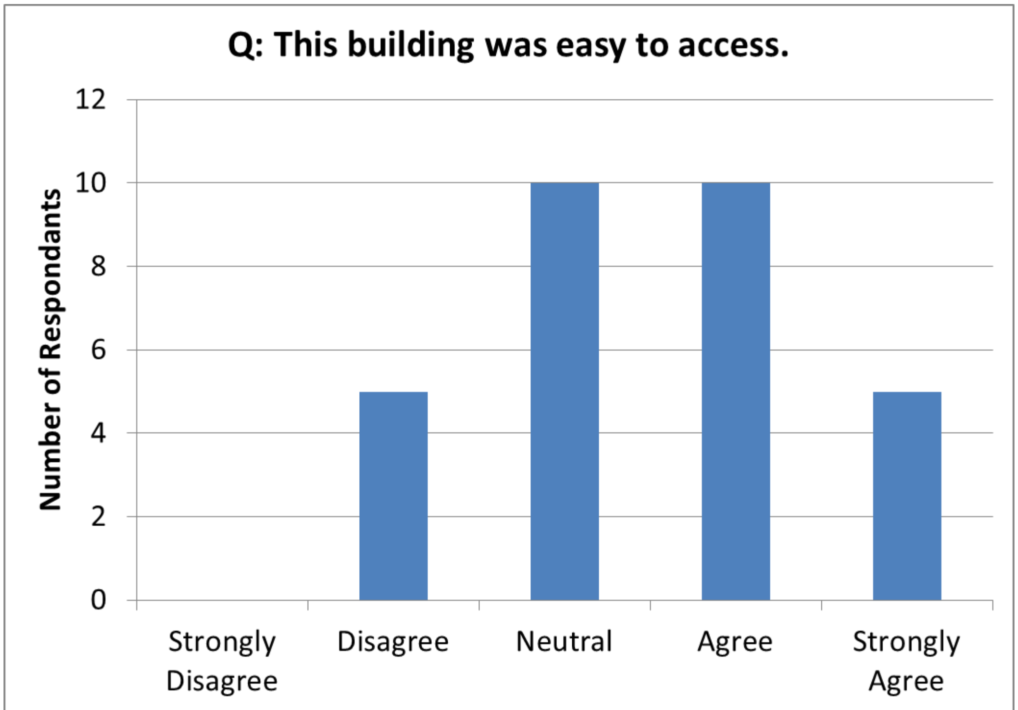
Appendix O: Site Visit Results for Building E

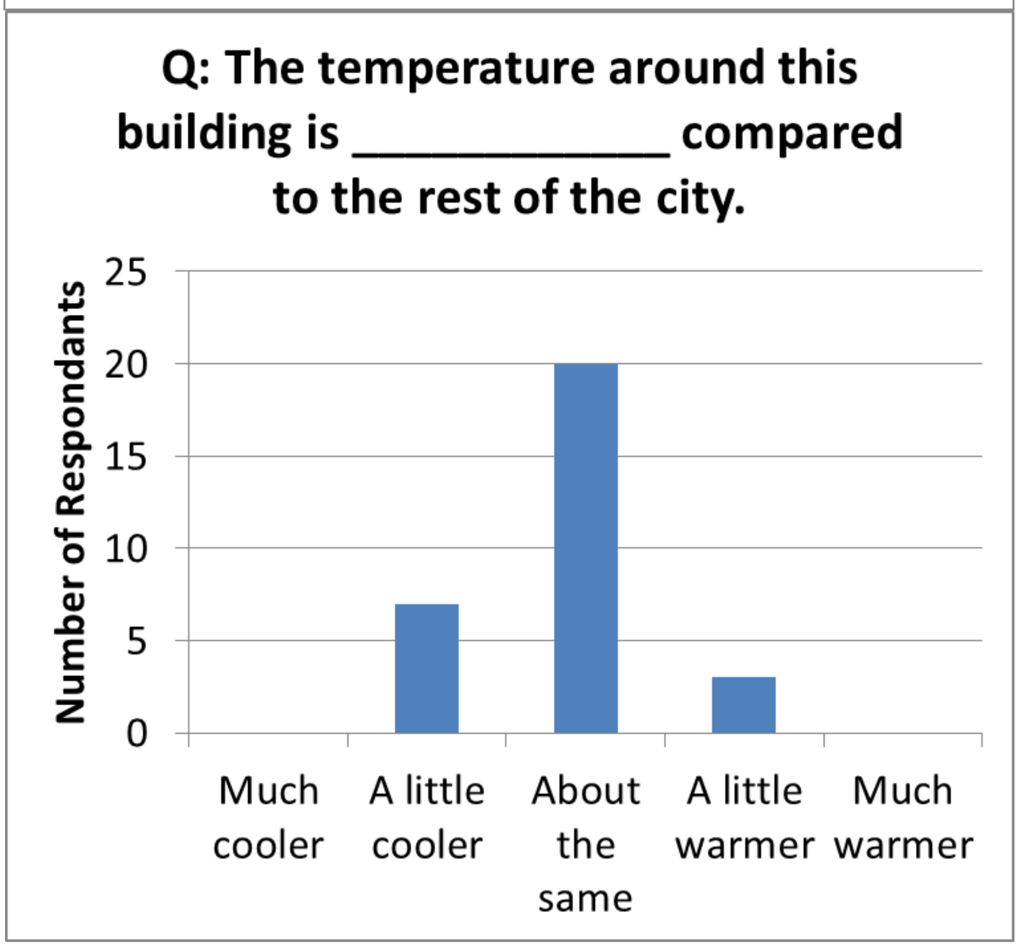





Would the garden be improved if there were more space to walk along the edge?
Number of Respondants
20
15
10
5
0
Yes
Maybe
No


Q: The BEAM certification of this building impacted my choice in visiting it.
Number of Respondants
18
16
14
12
10
8
6
4
2
0
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


Q: This building was easy to access.
Number of Respondants
12
10
8
6
4
2
0
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


Q: The temperature around this building is _____________ compared to the rest of the city.
Number of Respondants
25
20
15
10
5
0
Much cooler
A little cooler
About the same
A little warmer
Much warmer

Responses to “Are there any activities that you would like to be available here? If yes, what activities?”:

- Parent-child activities
- Variety show
- running
- picnic area
- games
- places to eat food and drink coffee
- performances
- exhibitions,
- charity activities,

Additional Comments:

- more advertising
- more recreational facilities
- guidepost to terminal has insufficient signage