C I N T R A F O R

Working Paper

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## Executive Summary

Green or sustainable building programs incorporate the environment, the economy, and human aspects into the design and construction of a building. Green buildings are created through an integrated process where the site, the building design, the construction, the materials, the operation, the maintenance, and the deconstruction and disposal of a building are all seen as being inter-related with the environment. As a result of this integrated process, it is thought that buildings can be made more environmentally friendly, more cost-effective and more resource and energy efficient, while providing a healthier living and working environment. Green building programs are slowly but surely emerging around the world in developed countries. The focus of this report is on the green building programs in Japan and China. The Japanese green building program is called CASBEE-Sumai (House) and the green building program in China is the Chinese Evaluation Standard for Green Building (also called the Three Star System). In addition, two other programs that have the potential to influence materials use in residential housing (the 200 Year House program and the Eco-Points program) have been adopted in Japan. This report provides an overview of these programs, explains the sections of the programs that relate to wooden building materials, and discusses how these programs could affect the use of wooden building materials in Japan and China.

To better understand builder's, architect's and design professional's perceptions and attitudes towards green building programs in China and Japan, surveys were conducted in both countries. A total of 406 surveys were collected in Japan and 150 surveys were collected in China. In addition, a series of informal interviews with building professionals were carried out in each country. These results of the surveys and interviews are summarized in the following report.

**Japan**

While Japanese housing starts declined substantially in 2009, they exceeded those in the US for the second year in a row. With approximately half of its housing starts being constructed from wood, Japan remains an attractive market for US manufacturers and exporters of wooden building materials. The recent adoption of the CASBEE green building program provides an opportunity to increase exports of wooden building materials from the US to Japan, particularly those that improve energy efficiency. However, the results of this research suggest that Japanese builders remain reluctant to use the CASBEE program as they perceive that there is little market demand for environmentally friendly houses and even less desire on the part of homebuyers to pay a premium for them, particularly given the slow economy that prevails in Japan. In contrast, Japanese builders expressed much more optimism about two other programs that could increase the demand for US value-added wood products in Japan, the 200 Year House program and the Eco-Points program.

The results of the survey clearly show that Japanese building professionals perceive wood to be the most environmentally friendly structural building material across all six of the environmental performance measure included in the survey. In contrast, steel is perceived as being the least environmentally friendly structural building material across most of the environmental performance measures. Energy efficiency of the house was found to be the most importance environmental attribute and it was rated as being significantly more important than all of the other attributes. Using water saving appliances and fixtures was found to be the second most important environmental attribute. Based on the results of this research, it appears that the various green building programs in Japan could provide new market opportunities for a variety of US value-added wooden building materials, including environmentally certified wood, energy efficient windows, water saving plumbing fixtures and insulation materials.

Finally, US government agencies and industry associations should be wary of the potential for CASBEE-Sumai to act as a non-tariff trade barrier by providing preferential treatment for domestic wood products. For example, the CASBEE program provides preferential points for domestic wood materials while both

the national government and an increasing number of prefectural governments provide subsidies to home buyers and home builders for homes built using domestic wood. These Japanese programs undermine the environmental benefits of wood by promoting an agenda designed to increase the demand for domestic wood relative to imported wood. In doing so, they ignore the environmental superiority of wood relative to non-wood building materials as clearly demonstrated by a life cycle analysis. In effect, these programs promote a myopic strategy that pits domestic wood against imported wood in a fight for market share within a fixed market segment. In contrast, the goal of the wood industries in both countries should be to expand the demand for all wooden building materials by promoting their environmental superiority relative to steel and concrete; an approach which would effectively increase the total market for wood products to the benefit of both domestic and foreign suppliers of wooden building materials.

**China**

With nearly twice the total floor space of the US and more than four times as much as Western Europe, China was expected to overtake Japan in 2009 to become the second largest construction market in the world. Yet green building in China's expanding building market is comparatively rare. The China Greentech Initiative, for example, estimates that certified green floor space constituted less that one percent of the new built environment in 2009. Recognizing the benefits of sustainable building, China's government has set ambitious targets and guidelines for green building, and developers, designers and builders are increasing their use of green materials and building principles.

Set against the backdrop of the global economic downturn, the Chinese housing sector has shown some encouraging signs of recovery. China's construction industry has grown at an average annual rate of 20% since 1990. Housing markets in major cities have recently started to pick up again thanks in part to the government's 4-trillion yuan stimulus package. According to China Data Center, investment in new construction between January and May 2009 reached over 2.5 trillion yuan, an increase of 43% compared to the same period last year.

Since 2006, the Chinese government has been working to promote its "4-savings and 1-environmental" housing ideology, which stands for: energy-saving, land-saving, water-saving, raw material-saving and less pollution. The Center for Housing Industrialization was founded in 1998. Since then, it has initiated several key national projects and drafted guidelines for improving productivity of construction and improving the "healthy" and "environmental" properties of residential buildings in urban areas. According to the 11th five-year plan initiated by the Ministry of Housing and Urban-Rural Development (previously, the Ministry of Construction), by the end of 2017 the level of industrialization of the Chinese housing sector will reach 30% from the current 7-8%, and the average service life of residences will increase from 50 to 100 years. China has started to develop 10 demonstration housing projects, 10 experimental cities, and 10 model construction enterprises. Currently, most construction in China is concrete and brick, while the market for wood frame construction has been growing very slowly due in large part to the government's tight restrictions on land use in urban areas. After the Sichuan earthquake last May, the Canadian Wood Association participated in the region's reconstruction projects and donated $8 million to help build wood frame houses for local residents. This has been reported widely in China and in turn has helped wood frame house win wider market recognition.

The new green building program in China, the Three Star System, has the potential to increase the demand for wooden building materials (both primary and secondary wood products) used in residential construction. The extent of its impact on demand in China will be influenced by the degree to which it is accepted and utilized by developers, builders, architects and home buyers. However, the Chinese green building program makes no specific mention of wood as a material of choice, suggesting that the US government and industry groups need to continue working with the Chinese government to encourage the use of life cycle analysis as the basis for future revisions to the green building program.

Despite this shortcoming of the Chinese Green Building Program, green building materials (particularly those related to energy-saving) will be increasingly in demand in China, led by public/commercial buildings and high-end residential projects in major cities such as Beijing, Shanghai and Guangzhou. These opportunities include energy efficient wood windows for high end apartments and condominiums. In particular, wood windows with either vinyl or fiberglass cladding on the exterior have strong potential because of their lower maintenance requirements. Other value-added wood products with strong market potential in China include cellulose insulation, environmentally certified wood, and high quality wood cabinets and flooring produced from certified wood targeted towards high–end apartments, condominiums and detached homes.

In China, almost 95% of respondents have heard of the green building program, a third planned to use the program and just over ten percent have used the green building program. Chinese builders report that the most important material attribute is using energy efficient products and materials, followed closely by using renewable materials. Both of these observations suggest that opportunities exist to market energy efficient wood products (e.g., wood windows and cellulose insulation) for use in multi-story, multi-family condominium and apartment buildings. The survey results obtained for the relative environmental performance of wood, concrete and steel clearly show that Chinese construction professionals perceive that wood and wooden structures provide superior environmental performance across a variety of environmental measures spanning the life cycle of a material. This trend is similar to the trend observed in Japan.

Finally, it should be noted that the US, Japan and the EU have all passed legislation requiring that importers of wooden products must be able to demonstrate that these products do not contain illegally harvested wood materials. As a result, we can expect to see the demand for certified wood in China continue to increase, particularly if the Russian government carries through on its intention of increasing its log export tax to 80% in January 2012.

Wood frame houses have increasingly been accepted into the Chinese market. In February 2009, the Shanghai government approved a B.C.-designed roofing system as part of a plan to renovate 10,000 city apartment buildings in the lead-up to the World Expo 2010 in Shanghai. As China moves to develop more and more "green" houses, experts predict that timber structures will continue to gain recognition by the government and construction sectors in China and open up new opportunities for green building materials and engineered wood products. Also, the projects being promoted by the Canadian Wood Association in Sichuan suggest that wood frame houses could be successful in the rural areas of China where land use is less regulated by local governments.

**Strategic Recommendations**

A number of programs (including green building programs) focused on improving the environmental performance and energy efficiency of homes have been adopted in China and Japan. At the same time, builders, architects and design professionals in both countries perceive wood to be the most environmentally friendly building material. They also believe that homes built from wood are more energy efficient than homes built from steel or concrete. These trends set the stage for promoting wood as a superior building technology as well as for promoting the superior environmental performance of value-added wood building materials such as wood windows and doors. For example, the Eco-Points program in Japan provides a unique opportunity to promote energy efficient US wood windows in both new home construction as well as the growing repair and remodel sector of the housing market (although wood windows must still gain approval under the Japanese fire code to be used within urban fire and quasi-fire zones).

The results of this research project clearly show that there are a variety of market opportunities for expanding US exports of value-added wooden building materials into both Japan and China. Perhaps the best market opportunity exists for increasing exports of wood windows given the emphasis in both countries on increasing the energy efficiency of new buildings. This will be easier to accomplish in China than in Japan where restrictive fire codes require the certification of wood windows used in fire and quasi-fire zones. In addition, the green building programs in Japan and China provide a good market opportunity to expand exports of cellulosic insulation, structural insulated panels, environmentally certified wood and value-added wood products used in interior applications that are made from certified wood (e.g., wood cabinets and flooring). Finally, good opportunities exist to increase exports of certified structural wood products such as glue-laminated beams, metric sized lumber, dimension lumber and treated lumber using the new generation of less toxic wood preservatives.

In order to increase the exposure of US value-added wood products among building professionals in Japan and China, US exporters should strongly consider participating in the wide variety of trade shows and trade missions by joining industry associations that are active in international markets and have a proven track record of providing access to qualified buyers in these countries. For example, the Evergreen Building Products Association offers trade missions to Japan and China several times a year. Similarly, the State of Washington sponsors trade missions for wood products manufacturers in Japan. Finally, industry associations such as the Softwood Export Council and the American Hardwood Export Council provide opportunities for US companies to rent booth space within the US Pavilion at trade shows in Japan and China. All of these associations provide tremendous logistical support for US exporters and manufacturers of wood building materials, allowing them to focus their energy on meeting potential customers for their products (a list of upcoming trade shows and missions is included in Appendix D).

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## Introduction

Green or sustainable building programs incorporate the environment, the economy, and human aspects into the design and construction of a building. Green buildings are created through an integrated process where the site, the building design, the construction, the materials, the operation, the maintenance, and the deconstruction and disposal of a building are all seen as being inter-related with the environment. As a result of this integrated process, it is thought that buildings can be made more environmentally friendly, more cost-effective and more resource and energy efficient, while providing a healthier living and working environment. Green building programs are slowly but surely emerging across the US and European landscapes and they have been introduced in Japan and China. These programs have been adopted to varying degrees across all levels of government. Industry, trade and environmental organizations are also looking to promote green building initiatives at a variety of levels. Most green building programs are designed or organized by guidelines, usually accompanied by a checklist or a point system that provides a relative measure of the environmental performance of the house. Typically, the guidelines are divided into sections such as energy use, water use, materials, indoor air quality, and construction waste. Points are awarded for incorporating designs, products and technologies that improve the environmental performance of the structure and reduce waste.

In general, there are two types of green building programs, voluntary and mandatory. Overall, a majority of the green building programs have been implemented on a voluntary basis. At the local level, cities are starting to adopt these programs and make them mandatory for publicly funded buildings. Government agencies are adopting these programs and requiring this type of building for two reasons; either as a model to demonstrate and encourage green building practices by the private sector, or, simply because they believe this type of building is more efficient from both an environmental and economic perspective and that public funds and natural resources go further with green buildings.

Green building programs have been designed to work with existing building codes and they have been successful in promoting their environmental benefits through an effective communications strategy. A number of programs assume that the long-term cost savings achieved from green buildings are a sufficient incentive to create demand for them. Within the US there are several green building programs that are currently in use. The two major green residential building programs in use at the national level are the US Green Building Council's LEED for Homes program (introduced in January 2008) and the National Association of Home Builders National Green Building Program (available since February 2008). Similarly, green building programs have been introduced in Japan and China. The Japanese green building program is called CASBEE-Sumai (House) whereas the green building program in China is called the Chinese Evaluation Standard for Green Building (often called the Three Star System).

The following section of the report begins with an overview of the green building program in Japan, including a description of the chapters of the green building program that specifically refer to wood building materials and transportation distances. The discussion then considers two other programs in Japan that are designed to improve the environmental performance of houses in Japan: the 200 Year House program and the residential housing Eco-Points program. The next section provides a discussion of elements of the CASBEE-House green building program that could potentially constrain the Japanese market for imported wood products: (1) the de-facto classification of domestic forests as being sustainably managed without an independent third party evaluation and (2) the provision of favorable consideration for locally sourced building materials that travel less than an arbitrarily defined distance with no reference to the overall LCA impacts of the material. Finally, there is a brief overview of the Chinese Evaluation Standard for Green Building (often called the Three Star System).

## Japanese Green Building Program: CASBEE-House

The growing awareness in Japan of the relationship between the built environment and the natural environment has progressed slowly and in stages. Public concern over air pollution or the effects of buildings on wind and light in the downtown core of large cities like Tokyo led to the introduction of environmental impact assessments in the late 1960's. During this period, the concept of environmental loadings was integrated into environmental assessments for buildings. In general, planners were only concerned with mitigating the negative effects that buildings have on their surrounding environments, such as large buildings that cause wind tunnel effects or that block the sun from reaching the streetscape. (*Note that some of the following discussion on the development of CASBEE-House is based on the CASBE-Sumai Technical Manual and the CASBEE website).*

In the 1980's increasing incidences of asthma and allergies led to a growing concern about the build-up of volatile organic compounds in houses, offices and schools. This phenomenon is referred to in Japan as Sick House Syndrome. In response to the problem, the government of Japan developed regulations (notably the F-4 star program) designed to minimize or eliminate the off-gassing of formaldehyde and other toxic chemicals from building materials used in the interior of a house.

These first two stages of the increasing consciousness about the built environment in Japan considered the indoor and exterior environments of a building separately. However, a move to consider the integration of the interior and exterior environments began as the consciousness of global environmental problems increased in the 1990's. In recent years, environmental performance assessment methods for buildings have begun to gain increased acceptance, particularly in developed countries. The main issue in these assessment protocols relates to the adverse environmental loadings that buildings impose on the environment. Some of these assessment protocols estimate the Life Cycle Assessment (LCA) by evaluating the environmental loads of a building throughout its life in conjunction with the performance of the building. However, a new approach was needed to integrate these components into a single measure of environmental performance.

### How the CASBEE-House Green Building Works

In Japan, the development of CASBEE (Comprehensive Assessment of Systems for Building Environmental Efficiency) started with the perception that the environmental performance assessment framework described above needed to be restructured into a new system based on a broader definition of sustainability. In Japan, the concept of a closed ecosystem was used for determining environmental capacities during an environmental assessment using a hypothetical enclosed space bounded by the borders of the building site, (Figure 1). CASBEE defines the concept of eco-efficiency in order to facilitate an integrated assessment of environmental performance both within and outside of the building site. In this context, eco-efficiency is defined as the "value of products and services per unit of environmental load" (CASBEE 2007). Defining efficiency in terms of the input and output loads leads to an expanded definition of eco-efficiency: (beneficial output)/ (input + non-beneficial output). The environmental loadings are defined as "the negative environmental impact that extends outside to the public environment beyond the hypothetical enclosed space" (CASBEE 2007). The improvement of environmental performance within the hypothetical enclosed space is defined as "the improvement in living amenities for building users" (CASBEE 2007). Consideration of both of these factors leads to the definition of the Building Environmental Efficiency (BEE) as the ratio of the Building Environmental Quality (Q) over the Building Environmental Loadings (L).

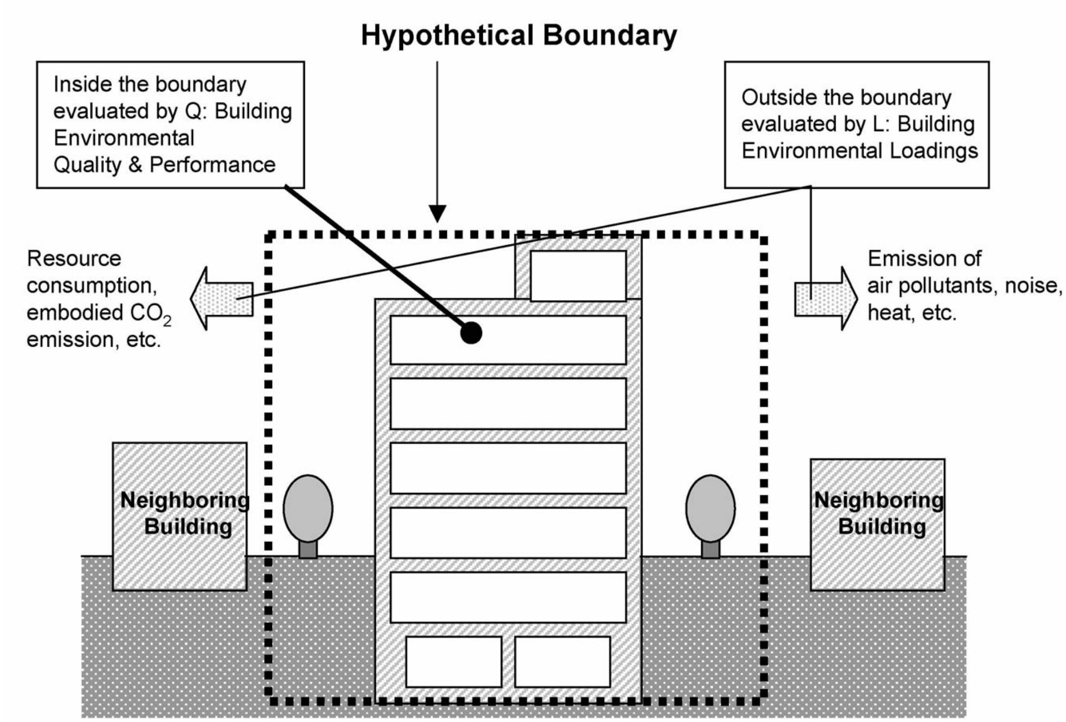


**Figure 1. Hypothetical enclosed space divided by the site boundary.**
*Source: CASBEE for Home (Detached Home) Tool 1-1. Technical Manual 2007 Edition.*

Japan has one national green building program for residential housing, called the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) – Sumai (House). The development of this program was begun in 2001 as a collaboration between industry, government and academia, with funding provided by the residential construction industry (50%) and the federal government (50%). The policy directions for the guidance of the development of the CASBEE-House program included: 1) the application of a market mechanism, 2) minimizing the role of government, 3) encouraging change through the disclosure of information rather than government regulation, and 4) supporting the integration of building technologies to reduce the environmental footprint of a house. The CASBEE-House green building program, which was released in July 2007, is designed to be a voluntary program, although subsidies at the local or national level (or both) have been made available to promote the program and encourage builders to incorporate green building considerations into the homes they design and build.

Since its introduction, CASBEE has gradually been introduced into local Japanese regulatory directives. The CASBEE program is primarily a "self assessment check system" designed to increase the environmental performance of buildings. It can also be used as labeling system, provided an independent third party verifies the assessment (although few builders have used it this way). As of July 2008, almost 2,500 (self) Assessment Reports had been submitted to local governments, and by August 2009, just 80 buildings have been independently certified (CASBEE 2009, Saunders 2008). The CASBEE program applies to a wide range of building types and focuses on construction issues and problems specific to Japan and Asia. The assessment tools developed by the CASBEE Secretariat extend from Pre-Design to Residential Renovation to Temporary Construction (CASBEE 2007) and include:

- CASBEE for Pre-Design (CASBEE-PD) helps with planning, site selection and evaluating a building's environmental performance at the pre-design stage.

- CASBEE for New Construction (CASBEE-NC) assesses buildings during the design and construction stages, with the goal of raising a building's Building Environmental Efficiency (BEE) value during the design process.
- CASBEE for Existing Buildings (CASBEE-EB) applies to buildings that have been occupied for at least one year.
- CASBEE for Renovation (CASBEE-RN) aides in generating proposals for building upgrades and assessing improvements.
- CASBEE for Temporary Construction evaluates buildings constructed specifically for short-term use of no more than five years, such as exhibition facilities.
- CASBEE-NC Brief Version simplifies the assessment process and allows a provisional assessment of new construction to be completed in about two hours.
- CASBEE for Regional Character has its own scoring guidelines specific to a particular region, such as CASBEE Nagoya.
- CASBEE for Heat Island Relaxation (CASBEE-HI) assesses efforts to alleviate the heat island effect of buildings in major urban areas such as Tokyo and Osaka.
- CASBEE for Urban Development (CASBEE-UD) focuses on city-center renewals in urban districts or development of large areas, including multiple buildings.
- CASBEE for Homes (CASBEE-H or DH) is tailored for detached homes (CASBEE 2006) (CASBEE 2007).

The CASBEE evaluation program covers the following four areas of assessment: (1) Energy efficiency (2) Resource efficiency (3) Local environment and (4) Indoor environment. To help the reader better understand CASBEE, the four assessment areas were reorganized in Figure 2. This figure shows the BEE numerator Q (Building environmental quality) and the BEE denominator L (Building environmental loadings). Q is subdivided into three items for assessment: Q1 (Indoor environment), Q2 (Quality of services) and Q3 (Outdoor environment) of the project site. Similarly, L is divided into L1 (Energy), L2 (Resources & Materials) and L3 (Off-site Environment). A summary of these items along with their corresponding sub-items and weightings are presented in Tables 1 and 2. It should be noted that the CASBEE-House manual further breaks the minor items in Tables 1 and 2 down into detailed items with their own weightings. It should also be noted that understanding these items is complicated and made difficult by the fact that descriptions of items often make reference to other building standards without providing further description within CASBEE. For example, in describing the requirements for obtaining the highest rating for the durability of the building frame (section Q2.1), CASBEE simply notes that "The building satisfies the requirements of Grade 3 in section 3-1, "Deterioration Resistance Grades (Building Frames, etc.)," of the Japan Housing Performance Indication Standards."

The CASBEE-House green building program makes specific reference to wooden building materials in the following sections of Part II of the program:

**Chapter $Q_H$2: Ensuring a Long Service Life**
Section 1.1: Building Frames, p. 54

**Chapter QH3: Creating a Richer Townscape and Ecosystem**
Section 4: Utilizing Regional Resources and Inheriting the Regional Housing Culture, p.85-86

**Chapter LRH2: Using Resources Sparingly and Reducing Waste**
Section 1.1.1: Building Frames, Wooden House, p. 116-121
Section 1.3: Exterior Materials, p. 126-127
Section 1.4: Interior Materials, p. 128-129
Section 1.5: Materials for the Exterior (Outdoor) area, p. 132

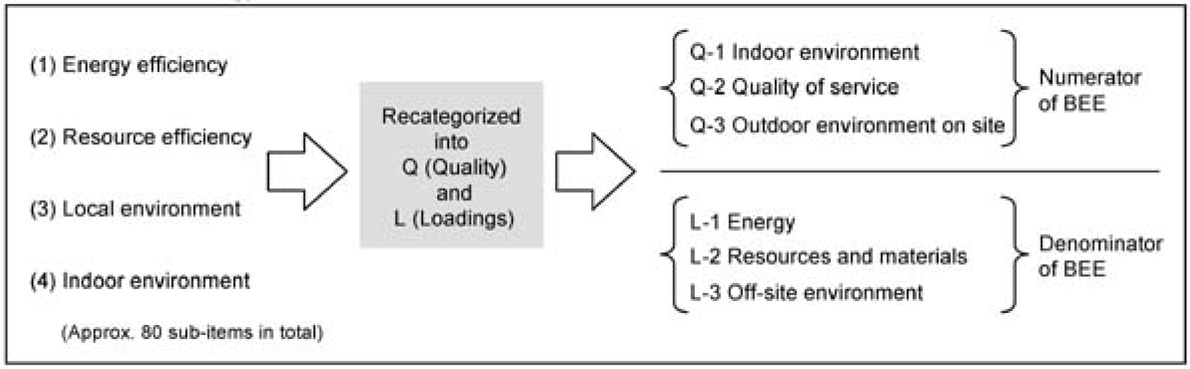


**Figure 2. Classification and rearrangement of assessment items into Q (Building environmental quality) and L (Building environmental loadings)**

*Source: CASBEE for Home (Detached Home) Tool 1-1. Technical Manual 2007 Edition.*

**Table 1. List of assessment items for measuring a building's environmental quality (Q).**

| **Q1: Comfortable, Healthy and Safe Indoor Environment (0.45)** | |
|---|---|
| Medium-level Items | Minor Items |
| 1. Heating and Cooling (0.50) | 1.1 Basic Performance (0.50) |
| | 1.2 Preventing summer heat (0.25) |
| | 1.3 Preventing winter cold (0.25) |
| 2. Health, Safety and Security (0.30) | 2.1 Countermeasures against chemical contaminants (0.33) |
| | 2.2 Proper planning for ventilation (0.33 |
| | 2.3 Precautions against crime (0.33) |
| 3. Brightness (0.10) | 3.1 Use of daylight (1.0) |
| 4. Quietness (0.10) | |
| **Q2: Ensuring a Long Service Life (0.30)** | |
| Medium-level Items | Minor Items |
| 1. Basic life performance (0.50) | 1.1 Building Frames (0.3) |
| | 1.2 Exterior wall materials (0.10) |
| | 1.3 Roof materials/flat roof (0.10) |
| | 1.4 Resistance against natural disasters (0.30) |
| | 1.5 Fire preparedness (0.20) |
| 2. Maintenance (0.25) | 2.1 Ease of maintenance (0.65) |
| | 2.2 Maintenance system (0.35) |
| 3. Functionality (0.25) | 3.1 Size and layout of rooms (0.50) |
| | 3.2 Barrier-free design (0.50) |
| **Q3: Ensuring a Richer Townscape and Ecosystem (0.25)** | |
| Medium-level Items | Minor Items |
| 1. Consideration of the townscape and landscape (0.30) | |
| 2. Creating the biological environment (0.30) | 2.1 Greening the premises (0.65) |
| | 2.2 Ensuring the biological habitat (0.35) |
| 3. Safety and security of the region (0.20) | |
| 4. Utilizing regional resources and inheriting the regional housing culture (0.2) | |

**Table 2. List of assessment items for building environmental loading measure (L).**

**L1: Conserving Water and Energy (0.35)**

| Medium-level Items | Minor Items |
|---|---|
| 1. Energy saving through building innovation (0.35) | 1.1 Control of thermal load of building (0.50) |
| | 1.2 Natural energy use (0.50) |
| 2. Energy saving through equipment performance (0.40) | 2.1 Air conditioning systems (0.27) |
| | 2.2 Hot water equipment (0.37) |
| | 2.3 Lighting fixtures, home electric appliances and kitchen equipment (0.25) |
| | 2.4 Ventilation system (.05) |
| | 2.5 Highly energy efficient equipment (0.6) |
| 3. ater conservation (0.15) | 3.1 water saving systems (0.75) |
| | 3.2 Rainwater use (0.25) |
| 4. Well-informed maintenance and operation schemes (0.10) | 4.1 Presentation of lifestyle advice (0.50) |
| | 4.2 Management and control of energy (0.50) |

**L2: Ensuring a Long Service Life (0.35)**

| Medium-level Items | Minor Items |
|---|---|
| 1. Introduction of materials useful for resource saving and waste prevention (0.60) | 1.1 Building frames (0.3) |
| | 1.2 Ground reinforcing materials, foundation work and foundations (0.20) |
| | 1.3 Exterior materials (0.20) |
| | 1.4 Interior materials (0.2) |
| | 1.5 Materials for the external area (0.10) |
| 2. Reduction of waste in the production and construction stages (0.30) | 2.1 Production stage (members for building frame) (0.33) |
| | 2.2 Production stage (members other than those for building frame) (0.33) |
| | 2.3 Construction stage (0.33) |
| 3. Promotion of recycling (0.10) | 3.1 Provision of information on materials used (1.0) |

**L3: Ensuring a Richer Townscape and Ecosystem (0.30)**

| Medium-level Items | Minor Items |
|---|---|
| 1. Consideration of global warming (0.33) | |
| 2. Consideration of the local environment (0.33) | 2.1 Control of the burden on the local infrastructure (0.5) |
| | 2.2 Preservation of the existing natural environment (0.50) |
| 3. Consideration of the surrounding environment (0.33) | 3.1 Reduction of noise, vibration, exhaust and exhaust heat (0.5) |
| | 3.2 Improvement of the thermal environment of the surrounding area (0.5) |

The information presented in Figure 2 and Tables 1 and 2 can be used to calculate the BEE (Building Environmental Efficiency) of a house. The use of BEE enables a simpler and clearer presentation of the building environmental performance assessment results using a star rating system (Table 3). The formula for calculating BEE is indicated below.

$$BEE = \frac{\textit{Building Environmental Quality}}{\textit{Building Environmental Loading}} \quad \frac{Q}{L} = \frac{25(S_Q-1)}{25(5-S_{LR})}$$

***Where:***

Q = 25 * (SQ – 1)
*SQ: Score of Q category = (0.45* SQ1 + 0.3 * SQ2 + 0.25 * SQ3)

***and***

L = 25 * (5 - SLR)
*SLR: Score of LR category = (0.35 * SLR1 + 0.35 * SLR2 + 0.3 * SLR3)

BEE values are then represented on a graph by plotting L on the x axis and Q on the y axis (Figure 3). The BEE value assessment result is expressed as the slope (Q/L) of the straight line passing through the origin (0,0). Building assessment that lie on the diagonal line (BEE = 1.0) are classified as ordinary buildings. A higher Q value and/or a lower L value results in a steeper slope which equates to a more sustainable building (Figure 3). Using this approach, it becomes possible to graphically present the results of building environmental assessments using areas bounded by these gradients (Eco-labeling). Figure 3 and Table 3show how the assessment results can be identified by the following categories:

**Table 3. BEE rankings used by the CASBEE-House green building program.**

| Rank | Assessment | BEE Value | Star Ranking |
|---|---|---|---|
| S | Excellent | BEE = 3.0 or higher | ★★★★★ |
| A | Very Good | BEE = 1.5 – 2.99 | ★★★★ |
| B+ | Good | BEE = 1 – 1.49 | ★★★ |
| B- | Fairly Poor | BEE = 0.5 – 0.99 | ★★ |
| C | Poor | BEE = 0 – 0.49 | ★ |

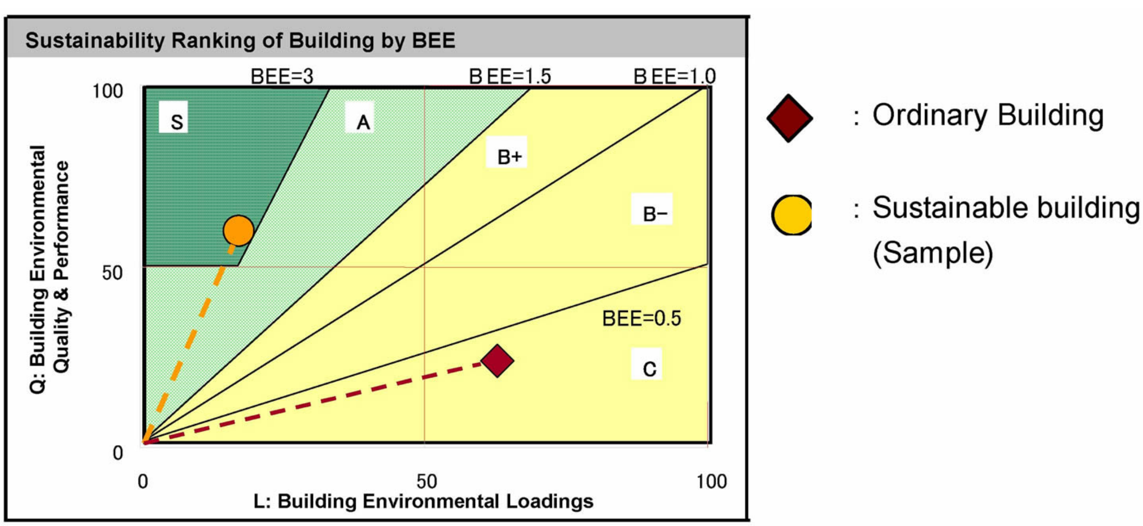


**Figure 3. Environmental labeling based on building environmental efficiency (BEE).**
*Source: CASBEE 2007*

Although CASBEE is designed to be a self-assessment tool, the Japan Sustainable Building Consortium advises that only CASBEE Accredited Professionals with expertise and knowledge of the environmental performance of buildings should conduct the assessments. To be accredited, candidates must attend a CASBEE Accredited Professional Registration System training course and pass an examination. As of 2007, there are more than 1,600 CASBEE Accredited Professionals in Japan (CASBEE 2006). However, the vast majority of projects using CASBEE-House still follow the self-assessment route by an unaccredited builder.

***Potential Problems with the CASBEE –House Program***

CASBEE-House is similar in structure to green building programs in the US (e.g., NAHB Green Home Building Guidelines) in that the home building process is evaluated against a series of guiding principles that are applied to the various stages of the construction process. While the specific stages of the construction process may vary somewhat depending on the green building program utilized, they typically include the following: 1) lot design, preparation and development, 2) resource efficiency, 3) energy efficiency, 4) water efficiency, 5) indoor air quality, 6) operation, maintenance and homeowner education, and 7) global impacts. Most green home building programs award points to homes that incorporate green design concepts, materials, products and technologies. Based on the total number of points accumulated, a house is awarded a specific rating that reflects its environmental performance.

However, there are several aspects of the CASBEE-House program that provide preferential consideration to domestic wood products at the expense of imported wood products and which could adversely influence the demand for North American wood products. The specific components of the CASBEE-House program that will be addressed include: a) the preferential treatment of wood sourced from domestic forests relative to imported wood, b) the de-facto specification of domestic wood as being sustainably managed while requiring that imported wood have third party certification in order to be classified as sustainable managed wood and c) the absence of a cradle-to-grave LCA assessment that takes into account the environmental performance of individual building materials across their life-cycle.

When specifying materials, green building programs are typically designed loosely, allowing architects and builders considerable flexibility in specifying the most appropriate materials, while still being able to meet the environmental criteria required to obtain the desired environmental rating. The guidelines for green building programs often identify the range of material options available. Architects and builders have expressed a clear desire that green building programs should be designed to guide, not dictate, the specification of the house design, the construction materials and construction techniques. However, in some green building programs certain building materials are implicitly identified as being more favorable based on the number of points awarded for their use (e.g., engineered wood products and sustainably managed wood) or they are explicitly specified based on some set of criteria.

Most green building programs discourage using wood products harvested from old growth forests. Instead, they favor recycled wood products or wood products derived from sustainably managed forests and plantations. As a result, the use of commodity softwood lumber is typically not a material choice that gains many points within a green building program. However, third-party certified softwood lumber that is verified as having been harvested from a sustainably managed forest is widely recommended and always preferred when lumber is used. Within the context of a green building program, it is important that there be consistency in the definition of sustainably managed forests and certified wood products in order to ensure transparency, maximize the availability of certified wood in the marketplace and place all products on an even competitive basis.

This is not the case with CASBEE-House however. Item 4 of section Q2 (CASBEE 2008c; pages 85-86) “Utilizing Regional Resources and Inheriting the Regional Housing Culture” specifically excludes imported wood from being awarded points when used in structural application within a house or in non-structural applications in either interior or exterior applications. In contrast, locally produced wood products can be awarded up to 2 points if both conditions are met. It is notable that this part of CASBEE-House does not specify that the wood must be derived from a sustainably managed forest in order to qualify for the additional points. Rather, CASBEE-House makes a distinction between two types of domestic wood: regionally distributed wood (*chiki zai*) and locally sourced wood (*giba sansai*). A house built using domestic wood from outside the region of use or imported wood would not qualify for the local wood provision and thus would gain no additional points under the CASBEE-House program. In contrast, a home built using locally sourced wood in the structure OR for the interior finishes would be awarded a point in the CASBEE-House program. If the home was built using locally sourced wood for the structure AND the interior finishes it would be awarded two points. CASBEE-House does not specify that a certain percentage of locally sourced wood must used and the use of even a small amount of locally sourced wood would presumably qualify for the credit.

In addition, CASBEE-House de-facto defines domestic wood as being sustainably managed, with no requirement that sustainability be verified using a third-party certification program (CASBEE 2009c; page117). In contrast, all imported wood must be certified as being sourced from sustainably managed forests in order to qualify for the sustainable material rating. The arbitrary decision to define domestic wood as sustainably harvested undermines the principle of transparency and scientific objectivity enshrined in most credible sustainable forest management programs. The lack of credible third-party verification of sustainability and legality also undermines consumer confidence since there is no guarantee that the wood being used is, in fact, legal or sustainable. This problem was highlighted in a recent report in the Kyodo News (2008) on the illegal logging of almost 700 trees in the Akan National Park in Hokkaido, Japan; illustrating the need for independent third-party certification programs, even in Japan. The decision to define domestic wood as sustainable also acts as a non-tariff trade barrier and places imported wood at a cost disadvantage in the marketplace since domestic lumber producers will not have to pay for the cost of certifying their lumber. All of those factors run counter to the stated objective of green building programs of improving the environmental performance of a home.

Finally, the CASBEE-House green building program makes reference to the $CO_2$ emissions generated during three phases of a buildings life: 1) construction, 2) repair, renewal and demolition, and 3) occupancy (CASBEE 2008c; pages 168-177). Unfortunately, this section of the program is not based on a life cycle assessment protocol and makes no provision for incorporating $CO_2$ emissions generated during the stages that occur prior to construction (e.g., mining/harvesting, manufacturing and transportation of a building material). By ignoring the high life cycle costs associated with steel and concrete during the mining, transportation and manufacturing phases, CASBEE-House seriously underestimates the environmental burdens (including $CO_2$ emissions, pollution generated and energy use) and costs associated with using steel and concrete relative to wood.

***Strategic Observations***

While the CASBEE-House program is a voluntary program that was jointly developed by the residential construction industry and the Ministry of Land, Infrastructure and Transportation (MLIT), the residential construction industry appears hesitant to adopt the program. Our interviews with managers of several large home builders indicated that the major home building companies have been involved, to varying degrees, in the development of the CASBEE-House program (including Mitsui Home, Sekisui House, Sumitomo Forestry, Misawa Home, and Daiwa Home among others). Our discussions with industry experts, suggest that small local home builders and medium-sized regional home builders are less likely to use the CASBEE-House green building program to any large degree because the primary customers for these homebuilders are older homeowners who are generally replacing an existing home. The consensus opinion is that these customers are typically more conservative, less environmentally aware and they are less likely to be willing to pay a premium to build a new house that is certified under the CASBEE-House program. In contrast, Japanese power builders (medium-sized regional or national home building companies that specialize in spec home developments that are often sold to younger, first time home buyers) appear to be more willing to use the program as a way of differentiating their homes in the marketplace and also because their primary customers tend to be younger, more educated homebuyers who are more concerned about the environment.

The ultimate success and widespread acceptance of the CASBEE-House green building program will rely on its acceptance by the large national home builders. While our discussions with managers at several large home building companies suggest that most large home building companies are not likely to use the program to any large degree, the managers we talked with noted that if one large company were to widely adopt the program, then other large homebuilders would likely follow to prevent their competitor from gaining a marketing advantage with potential home buyers. There was also some concern among industry managers that the CASBEE-House program might transition from a voluntary program to a mandatory program similar to the process that has occurred with the Green Procurement program, although this is probably more of a concern in the commercial construction sector than the residential construction sector.

## Other Programs that Affect the Residential Construction Sector in Japan

The past two years have seen the introduction of two other environmentally-oriented programs that affect the residential housing sector in Japan and which deserve mention in this report. The first is a program introduced by Prime Minister Yasua Fukuda designed to improve the quality and longevity of residential housing in Japan. This program is referred to as the 200 Year House or the Long-Term Superior Housing program. The second program, the Housing Eco-Points program, was primarily developed as an economic stimulus measure designed to encourage builders and consumers to purchase energy efficient building materials, although a secondary focus of the program is to improve the environmental performance and energy efficiency of Japanese homes and condominiums. Both programs are briefly discussed below.

### *200 year house program*

The housing stock in Japan remains heavily weighted towards older, poor quality houses that were built prior to 1980. The most recent estimate is that over 30 million homes built before 1980 will need to be replaced rather than repaired, with 14 million of these houses being built prior to 1970. This older housing stock represents 45.8% of the total housing stock in Japan and this inventory of older homes will continue to influence annual housing starts into the future. Considering these older homes, almost 18 million (58.7%) are single family dwellings. Traditionally, Japanese houses are replaced every 20-25 years and most new homes are built on sites where the previous home has been demolished. Given the poor quality of most of the older post-war housing (1945-1979), it has generally been considered more cost-effective and efficient to demolish older homes rather than repair or remodel them. For this and other reasons, a resale market for used housing has never developed in Japan. The lack of a resale market for used housing in Japan is illustrated by the comparative sales data for new and used houses in Japan, the US, the UK and France. Whereas only 13.1% of the total annual home sales in Japan were for used homes, in the US, the UK and France this ratio is significantly higher at 77.6%, 88.8% and 66.4%, respectively. A Japanese policy to promote longer lived homes (the so-called 200 Year House program) and replace older homes with more energy efficient and environmentally friendly homes should continue to support annual housing starts.

The Long-Term Superior Housing System (200 Year House program) provides a variety of incentives and tax breaks to encourage homebuyers and homebuilders to favor factors such as high durability, seismic resistance, ease of maintenance or repair and ease of renovation or retrofitting; which all help to improve the lifespan of a house. While these incentives and tax breaks apply to standard housing and houses built under the 200 Year House program, the size of the benefits are substantially larger for durable housing. For example, homebuyers who purchase a durable house will be able to increase the amount of their home loan that they can deduct from their income taxes (the increase will be approximately ¥1,000,000), homebuyers will be able to obtain longer mortgages (extending up to 50 years vs. the usual 35 years), and they could see their property taxes reduced by between 25% to 50% for up to seven years (Tables 4 and 5).

In addition, if the total mortgage deduction exceeds the amount of income tax owed by the homeowner, then they can apply up to ¥97,500 of the excess per year to their property taxes (jyumin-zei). Finally, there are several other financial incentives that buyers of long-term durable houses can benefit from, including: 1) The tax for registering a new 200 Year House is reduced from 0.15% to 0.10% and the tax for transferring the registration of a 200 Year House is reduced from 0.30% to 0.10% (until March 31, 2010); 2) the tax exempt portion of the real estate acquisition tax is increased from ¥12 million to ¥13 million (until March 31, 2010); 3) for single family housing, the fixed property tax is reduced to half for three years for a standard house and for five years for long-term superior housing (until March 31, 2010); and 4) the Japan Housing Finance Agency (former Government Housing Loan Corporation) has established a 50 year loan for long-term superior housing. The interest rate can be reduced by one percent for the first ten years and 0.3 percent for a subsequent ten years when it meets the Flat 35S criteria (Hi-Spec Technical Criteria for a durable house).

**Table 4. Summary of incentives for standard houses built by 2013.**

| **Standard House** | | | | |
|---|---|---|---|---|
| **Year in which House is Occupied** | **Maximum Mortgage Eligible For Deduction** | **Term of Deduction from Income Tax** | **Percentage of Deduction** | **Maximum Deduction** |
| **2009** | 50 Million Yen | 10 Years | 1.00% | 5 Million Yen |
| **2010** | 50 Million Yen | | | 5 Million Yen |
| **2011** | 40 Million Yen | | | 4 Million Yen |
| **2012** | 30 Million Yen | | | 3 Million Yen |
| **2013** | 20 Million Yen | | | 2 Million Yen |

**Table 5. Summary of incentives for long-term durable houses built by 2013.**

| **Long Term Superior House** | | | | |
|---|---|---|---|---|
| **Year in which House is Occupied** | **Maximum Mortgage Eligible For Deduction** | **Term of Deduction from Income Tax** | **Percentage of Deduction** | **Maximum Deduction** |
| **2009** | 50 Million Yen | 10 Years | 1.20% | 6 Million Yen |
| **2010** | 50 Million Yen | | 1.20% | 6 Million Yen |
| **2011** | 40 Million Yen | | 1.20% | 6 Million Yen |
| **2012** | 30 Million Yen | | 1.00% | 4 Million Yen |
| **2013** | 20 Million Yen | | 1.00% | 3 Million Yen |

The 200 Year House program has just begun and the success of the program will hinge upon a variety of things, not the least of which is the development of a housing resale market. This is an idea which Japanese homebuyers have resisted in the past; preferring to regard housing as a depreciating consumer good rather than as an appreciating investment asset. Given the poor quality of older housing in Japan, and consumer resistance to buying used homes, the establishment of a growing and healthy resale housing market is uncertain at best, particularly at a time of a declining population when a reduced demand for housing is predicted.

Despite these concerns, recent housing start data compiled by the Ministry of Land, Infrastructure and Transportation suggests that the 200 Year House program has been much more successful than expected. For example, the total number of housing starts approved under this program in February 2010 totaled 5,854 units (of which 99.8% were single family homes). This represents 8.5% of total housing starts for the month. Overall, there have been a total of 49,958 units approved since the program was initiated on June 4, 2007, of which over 99% have been single family residences. However, houses built under this program still represent just 1.1% of total housing starts between June 2007 and February 2010. The increasing use of the 200 Year House program suggests that it would be useful to for US exporters to consider market opportunities for high quality, durable US wood products and building materials within this sector of the market.

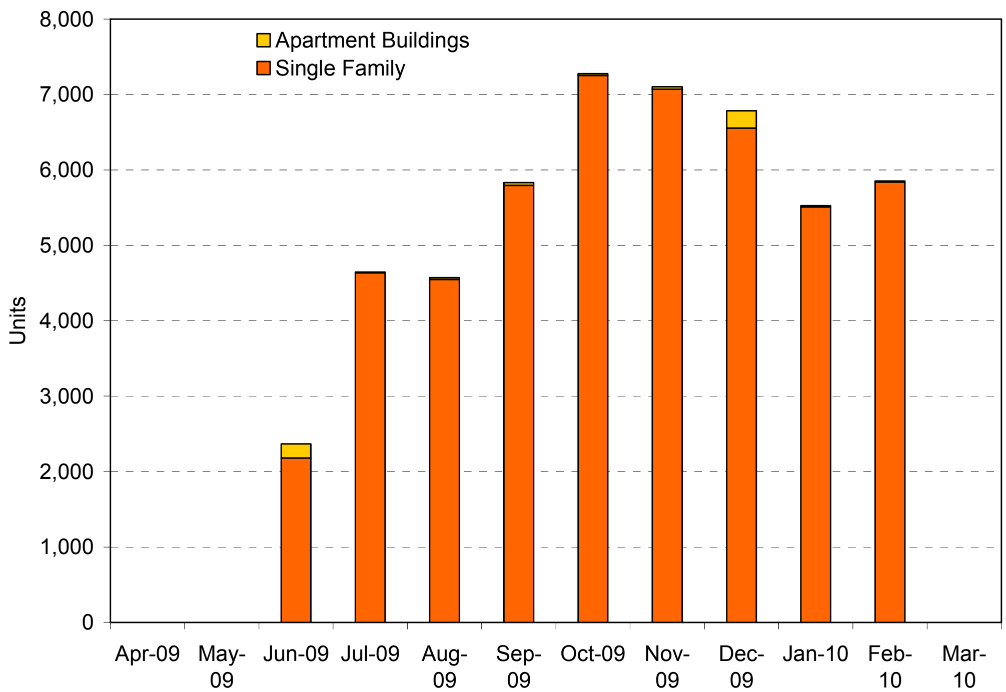


**Figure 4. Number of housing units built under the Long-Term Superior Housing Act.**
*Source: (MLIT 2010):* http://www.mlit.go.jp/common/000109844.pdf

***Housing eco-points program***

Another new program that has recently been extended into the housing sector is the Eco Point program. Originally implemented in July 2009, the Eco Point system was designed to: (1) reduce $CO_2$ emissions, (2) provide a stimulus for the economy and (3) encourage the adoption of ground-wave digital television. The idea behind the original ¥290 billion program was that consumers who purchased approved energy efficient appliances would receive eco-points (worth 5% of the price of an air conditioner or a refrigerator and 10% of the price of a digital television) that could be used to purchase a variety of eco-friendly consumer goods, including transportation passes and gift cards.

For example, purchasing an energy efficient air conditioner can earn between 6,000 and 9,000 eco-points (each eco-point is worth ¥1), an energy efficient refrigerator can earn between 3,000 and 10,000 eco-points, and an energy efficient digital television can earn between 7,000 and 36,000 eco-points (based primarily on screen size). The eco-point program, which was originally scheduled to end on March 31st, 2010 has been extended through the end of 2010 because of its popularity and the larger than expected stimulus to the economy.

In December 2009, the Japanese government expanded the eco-point program to include green building materials used in new and remodeled homes. The new program began on March 8th, 2010 and applies to all construction projects begun after January 1st, 2010 and completed by December 31st, 2010. The program provides an additional ¥100 billion in funding for the residential housing sector. The intent of this new program is to help stimulate the economy and to encourage home owners to recognize the need to reduce greenhouse gas emissions by choosing environmentally friendly building materials and construction technologies.

The program applies to new construction and three type of renovation projects, including the installation of energy efficient double-panes windows (earns between 2,000 and 18,000 eco-points), the installation of insulation in exterior walls (earns 100,000 eco-points), ceilings (earns 30,000 points) or floors (earns 50,000 points), and installation of barrier free features in conjunction with either of the two previous energy efficiency improvements. The maximum number of eco-points awarded per house or condo is 300,000.

Unlike the original eco-points program, home improvements require third-party verification before they are certified to receive the eco-points. The program is expected to have a bigger impact on the remodeling sector, since home owners are likely to delay building a new home during the current economic slump in favor of undertaking remodel projects that improve the energy efficiency of existing homes and reduce heating and cooling costs.

## Chinese Evaluation Standard FOR Green Building (Three Star System)

With nearly twice the total floor space of the US and more than four times as much as Western Europe, China was expected to overtake Japan in 2009 to become the second largest construction market in the world. Yet, green building in China's expanding building market is comparatively rare. The China Greentech Initiative, for example, estimates that certified green floor space constitutes less that one percent of the new built environment in 2009 (Chrachilov et al. 2009). Recognizing the benefits of sustainable building, China's government has set ambitious targets and guidelines for green building, and developers, designers and builders are increasing their use of green materials and building principles (Crosthwaite and Connaughton 2008; Crachilov et al. 2009).

China's first attempt to create a green building standard is the Evaluation Standard for Green Building (GB/T 50378-2006), also referred to as the Three Star System. It was introduced in 2006 and is administered by the China Green Building Council. This standard complements BREEAM and LEED, which presently are used in China for office buildings for multinational companies or upscale apartment buildings. The Evaluation Standard for Green Building has two different standards, one for residential buildings and one for large commercial or public buildings (Pastermack 2008; NEEC; People's Republic of China 2006).

### How the Chinese Evaluation Standard for Green Building Works

The Standard rates buildings in six categories, using a variety of "basic conditions" or prerequisites and "general conditions" or credits. The categories include the following:

1) Land & Outdoor Environment
2) Energy & Energy Efficiency
3) Water & Water Efficiency
4) Material & Resource Efficiency
5) Indoor Environmental Quality
6) Operation Management

A seventh category, "advanced conditions", contains strategies that are both cutting-edge and harder to implement. The Standard's credit-based system allows developers and designers to be flexible in deciding which credits they wish to pursue (NEEC). Green buildings need to meet all of the conditions described under Basic Conditions for residential and public buildings described in the Standard. They are further rated into three green rating levels, identified by the number of stars awarded, and based on the number of conditions met under the general conditions and advanced conditions listed within each section of the standard. For residential buildings, there are a total of 95 items: 46 basic conditions, 40 general conditions and 9 advanced conditions. For public buildings, there are a total of 83 items: 26 basic conditions, 43 general conditions and 14 advanced conditions (Table 6).

**Table 6. Item Requirements for Green Building Evaluation Standard (Residential Building)***

| Rating | General Conditions (40 Items in total) | | | | | | Advanced Conditions (9 items) |
|---|---|---|---|---|---|---|---|
| | Land and Outdoor Environment (8 items) | Energy & Energy Efficiency (6 items) | Water & Water Efficiency (6 items) | Material and Resources (7 items) | Indoor Environmental Quality (6 items) | Operation and Management (7 items) | |
| ✭ | 4 | 2 | 3 | 3 | 2 | 4 | - |
| ✭✭ | 5 | 3 | 4 | 4 | 3 | 5 | 3 |
| ✭✭✭ | 6 | 4 | 5 | 5 | 4 | 6 | 5 |

** People's Republic of China 2006*

For example, the conditions listed under section 4.4 (Materials and Resources) of the Residential Buildings Standard consist of the following:

**Basic Conditions**

**4.4.1** The allowable content of hazardous substances contained in building materials shall comply with the requirements specified in GB18580~18588 and GB 6566.

**4.4.2** Architectural design shall be simple in form without too much decorative elements.

**General Condition**

**4.4.3** A minimum of 70% of the total weight of the building materials and products shall be manufactured within 500 km of the project site.

**4.4.4** Pre-mixed concrete shall be used as an in-situ concrete.

**4.4.5** For concrete structures, high performance concrete and high strength steel are used as the structural material.

**4.4.6** Solid waste derived from building construction, demolition of the existing building and site clearance shall be classified for treatment. Reusable and recyclable materials shall be collected and returned for more applications.

**4.4.7** Application of recyclable material shall be given consideration during the stage of material selection. Use of recyclable material shall account for 10% minimum of total weight of building material.

**4.4.8** Design and construction of structural and interior finishes shall be conducted within the same stage, avoiding demolition and disassembly of existing buildings and facilities.

**4.4.9** Use of building material manufactured by waste, with the guarantee on required performance level, shall account for 30% of total consumption of the same type of material.

**Advanced Conditions**

**4.4.10** Use of structural system with low impact on the resource consumption and environment.

**4.4.11** Use of reusable building material shall account for 5% minimum.

No mention of wood or wooden building materials is made within the Chinese green building program. In fact, the conditions listed under the Materials and Resources section of the Standard imply that reinforced concrete structures are favored over other types of construction materials and technologies. In addition to satisfying all controlling items, to be rated as "green" a building must also satisfy the requirements of general items and preference items in each category. When a certain item is not applicable to the conditions of a building; for example, the region, climate or building type, the item can be excluded from evaluation. The total items for that evaluation will be reduced, and the requirement for the number of items will be adjusted proportionally (People's Republic of China 2006). Buildings are rated according to three grades: 1-star, 2-stars or 3-stars, which correspond roughly to the LEED Silver, Gold and Platinum ratings. Ratings are awarded after a building has been operating for one year (People's Republic of China 2006).

### Observations on the Chinese Green Building Program

The green building program in China is evolving into a new stage of development that features standardization, industrialization, systematization, and a higher level of government support. It is reported that the Beijing Municipal Government is working to apply mandatory green building standards to all high-end residential buildings to be started in the city. These standards will specify the use of energy-saving and green building materials as part of developer qualifications in order to join the land bid.

However, several major challenges remain and need to be addressed in the future:

***1) Lack of policy and market incentives***

Despite the fact that there are many green building pilot projects in China, industry-wide participation has been low. This is because, to most industry practitioners, the green building program means high costs and low returns. The system is yet to achieve maturity and scales of economy. In the meantime, the fast-growing housing market and buyers' low awareness of the green building program have led an increasing number of developers to seek short-term returns, at the cost of long-term environmental benefits and improved housing quality. As an integrated system, the Chinese green building program needs high level support from government, as well as close collaboration across all industry sectors including developers, building materials manufacturers, distributors, designers, builders, government agencies and financial institutions. Industry observers have suggested that the government should play a bigger role in developing the green building program and offer sufficient policy and tax incentives to encourage industry-wide participation.

***2) Lack of scientific and credible standards for performance evaluation***

With the government's increasing involvement in the development and implementation of green building programs, new standards have been released recently, including the national "three-star" standard, as well as several local standards in Guangxi, Jiangsu and Chongqing. However, these standards are often criticized for their lack of scientific performance measures. Current standards are developed in a largely descriptive form to guide the design and construction process, rather than focusing on a performance evaluation of the completed building. This system may encourage excessive subjectivity during the green building rating process and reduce the credibility of the entire system. Also, with their common emphasis on land-saving, energy-saving, water-saving and material-saving technologies, these standards largely overlook aspects of economy and comfort, which may prevent green building's wider market acceptance, particularly with home buyers. These standards may also be misleading the market because they tend to focus on individual technologies and equipment applications, while ignoring the building system's integrated performance. Industry experts have called for more credible GB standards and classification systems that can be used to distinguish high quality projects from lower quality ones, and also account for regional differences in terms of economic, cultural and geographical conditions.

***3) Lack of design capacity***

There is a lack of well trained designers and architects who are familiar with GB systems. Current university education and design institute systems need to be reformed to catch up with increasing market demand for green building projects which require high levels of specialization and cross-industry collaboration. In the future, the industry may see an increasing number of specialized design studios available to provide green building services.

***4) Lack of financial support for residential building renovation projects***

According to China's "energy-saving guidelines for residential buildings" issued on Oct 1, 2008, government and property owners should take co- responsibility in providing funds needed for building renovation projects with an aim to improve old building's energy, electricity and water-use efficiency. However, in practice, insufficient government funds (and policy incentives), and lack of financing by major banks have become major barriers to the rapid implementation of the GB process and have therefore contributed to the failure to meet the program's target goals.

***5) Integrate Life Cycle Assessment into the Green Building Program, especially with respect to the specification of structural building materials***

As mentioned previously, wood as a structural building material receives no mention in the Chinese green building program. In fact, despite a long history of building with wood, modern China has little experience with wood buildings. The recent adoption of a wood building code for houses and low-rise structures means that it is now possible to build with wood, although it is still relatively rare to see a wood frame building being built. Integrating life cycle assessment techniques into the green building program is an effective way to improve the environmental performance of homes and low rise commercial structures (e.g., schools and health clinics) as well as the earthquake resistance of these structures.

Overall, the Chinese central government is eager to address the country's growing environmental problems – among which, pollution (GHG emission) reduction and energy conservation are given top priorities. On the financing side, the central government issued a Chinese green credit policy in July 2007 with the aim of encouraging banks to shift their financing focus from high-pollution and/or energy-consuming projects to "clean" projects that provide energy-saving and emissions reduction. The policy was jointly developed by the State Environmental Protection Agency (SEPA), the People's Bank of China (PBOC), and the China Banking Regulatory Commission (CBRC). The Ministry of Finance and the Ministry of Environmental Protection have recently issued a green procurement policy designed to encourage the use of environmentally friendly building products which are certified by the China Environmental Labeling Program.

With regard to the green building program, the government is likely to apply mandatory green building standards to all public building construction and residential building renovation projects favoring energy-saving technologies and equipment. In addition, in big cities such as Beijing, local government is set to enforce green building program requirements in all new high-end residential projects with the goal of improving energy-efficiency. Leading developers such as Vanke, one of China's largest development companies, have made green building development a long-term strategy and have set a target of gradually increasing the proportion of green building projects within the company's portfolio of projects.

In the near future, demand for green building products (particularly those related to energy-saving) in China is expected to increase, led by public/commercial buildings and high-end residential projects in major cities such as Beijing, Shanghai and Guangzhou. These opportunities include energy efficient wood windows for high end apartments and condominiums. In particular, wood windows with either vinyl or fiberglass cladding on the exterior have strong potential because they have lower maintenance requirements. Other value-added wood products with strong market potential in China include cellulose insulation and high quality wood cabinets targeted towards high –end apartments, condominiums and detached homes.

One recommendation for US exporters of building materials is to continue to work with industry associations such as EBPA, AHEC and SEC who have been actively and successfully promoting US wood products to the Chinese high-end residential markets since the early 2000's. Also, "emerging markets" such as Sichuan earthquake zone rebuild projects (and more recently Yushu in Qinghai Province) may offer good opportunities for US wood building products and construction technologies in low-rise public buildings, including wood frame (such as health clinics and schools).

Given the size of the country and large regional difference, a significant amount of technical support and capacity-building work will be demanded in China before its green building program is fully established. US suppliers and industry associations can expect to further benefit from this process by helping local agencies develop regional green building standards and train more designers, architects and builders.

## Survey of Green Building Programs in Japan and China

### Results of the Japanese Green Building Survey

Several new programs enacted in Japan, including the CASBEE-House green building program, the Long-Term superior housing program and the eco-point program have the potential to increase the demand for wooden building materials (both primary and secondary wood products) used in residential construction. The extent of their impact on demand is influenced by the degree to which they are accepted and utilized by home builders and architects. However, the Japanese green building program also has the potential to place imported wooden building materials at a competitive disadvantage relative to domestic building materials. For example, CASBEE-House de facto defines Japanese forests as being sustainably managed while requiring imported wood to be third-party certified as having been harvested from sustainably managed forests before it could qualify for favorable consideration (CASBEE 2008c).

#### Survey Methodology

To better understand how builders and architects perceive and use green building programs in Japan, a series of surveys were conducted at a variety of professional conferences and trade shows. The following discussion is based on 406 surveys collected from Japanese home builders and architects at the Tokyo Home Show (November 2009), the State of Washington/Evergreen Building Products Association's fall trade mission in September 2009 (which included seminars in Maebashi, Mito, Tokyo, Chiba, and Shizuoka), and the Architecture and Construction Materials show in Tokyo (March 2010). The survey was designed to collect information to help better understand home builder's and architect's attitudes towards green building programs and their perceptions of the environmental attributes of wooden building materials relative to non-wood building materials.

#### Results

Sixty-six surveys (16.3%of total surveys) were collected during the State of Washington/Evergreen Building Program annual seminar mission in Japan. Two hundred seventeen (53.4%) surveys were collected during the Japan Home Show and one hundred twenty-three (30.3%) surveys were collected during the Architecture and Construction Materials show in Tokyo. Among the responses, 32.5% were architects and design professionals and 67.2% were active home builders.

It is well known that there is a large degree of heterogeneity within the home building industry in Japan, with a large number of small sized builders (komuten) and very large builders coexisting in the marketplace. These companies employ very different business strategies, with komuten relying on word-of-mouth advertising and a good reputation to gain customers within localized markets whereas large builders tend to have a national focus and use their large size to keep both construction costs and time down. As a matter of practical convenience, builders were categorized into three groups based on their total number of housing starts in 2008; 1) small sized builders or *komuten* built less than 25 houses, 2) medium-sized builders built between 25 and 199 housing starts, and 3) large builders built 200 or more housing units. An analysis of the survey respondents showed that *komuten* represented 68% of responses, medium-sized builders were 17% of responses and large builders were 14% of responses (Figure 5).

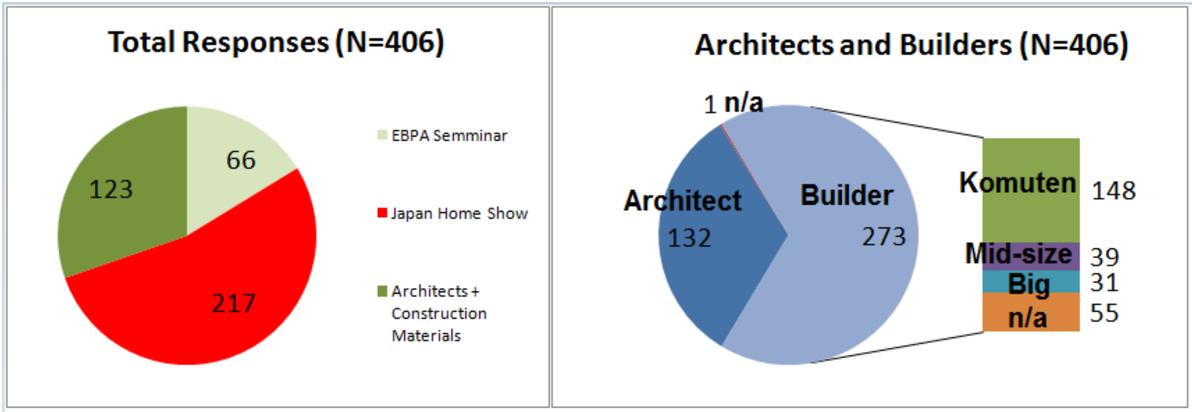


**Figure 5. Analysis of survey respondents.**

### Awareness and Use of the CASBEE-House Green Building Program in Japan

A surprisingly high proportion of survey respondents (69.7%) reported that they had never heard of the CASBEE-House green building program. Of those respondents who indicated that they had heard about CASBEE-House (30.3%), the largest proportion reported that they had never used CASBEE-House. Overall, only 8.7% of the respondents indicated that they had built a home using the CASBEE-House green building program (Table 7).

**Table 7. Please indicate your experience with Japan's green building code.**

| Experience | Number | Percentage |
|---|---|---|
| Have used it | 34 | 8.7% |
| Have heard, but never used it | 85 | 21.6% |
| Never heard of it | 274 | 69.7% |
| **Total** | **393** | **100%** |

#### *Architects versus Builders*

The survey data indicated that there were some differences in the awareness and use of the CASBEE-House green building program between builders and architects as well as between large builders and small builders (Figures 6 and 7). Only 33.2% of builders and 24.2% of architects reported knowing about CASBEE-House and just 5.6% of architects and 10.5% of builders indicated that they offered houses under the CASBEE-House program. A statistical analysis of the survey data found that there was not a significant different between architects and builders awareness or use of the CASBEE-House program.

#### *Large Builders versus Medium-sized Builders and Small Builders (Komuten)*

An analysis of the survey data found that large home builders were more likely than small builders to be aware of CASBEE-House and they were also more likely to have built a home using the green building program (Figures 8 and 9). About 79.3% of large builders had heard about CASBEE-House whereas only 39.5% of medium-sized builders and 25.7% of small builders (komuten), had heard about CASBEE-House. About 28.6% of big builders reported that they had built homes using CASBEE-House, while for medium-sized builders and komuten, the numbers were just 10.5% and 6.9%, respectively. A statistical analysis of the survey data found that large builders were significantly more likely to have heard of CASBEE-House and to have built homes using the green building program than were either medium-sized builders or small komuten.

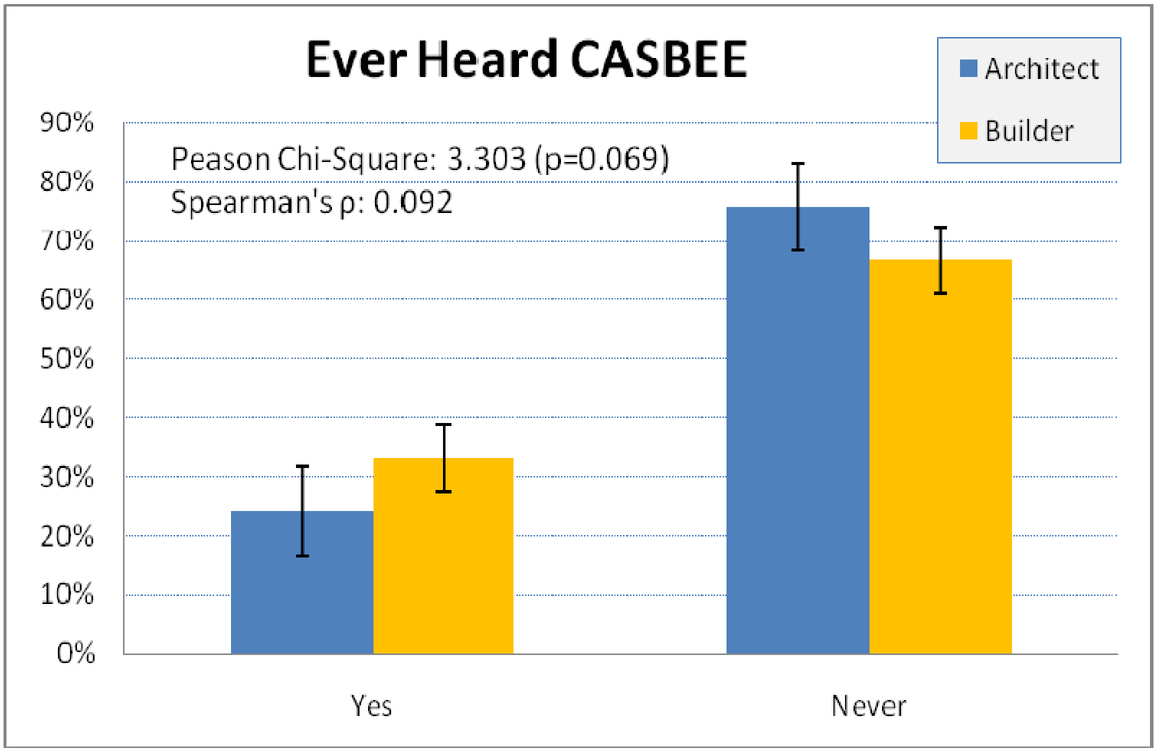


**Figure 6. Comparison of builders and architects awareness of the CASBEE-House green building program.**

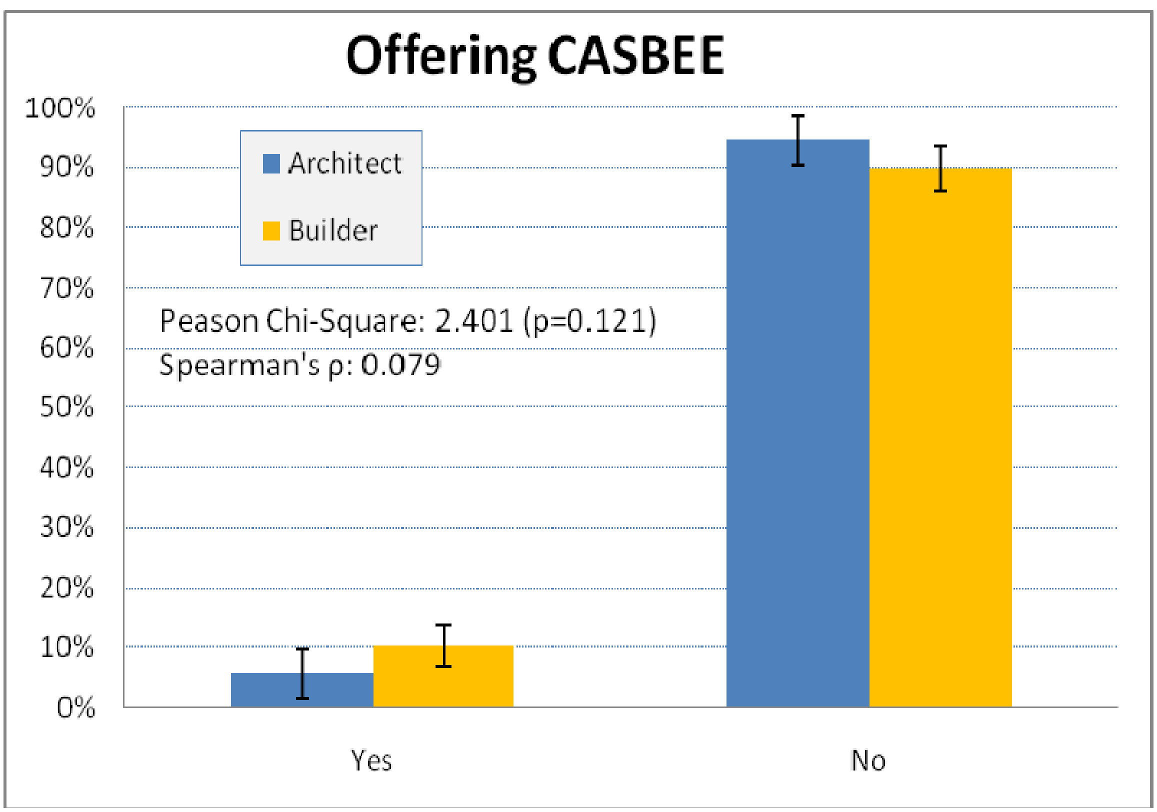


**Figure 7. Comparison of builders and architects use of the CASBEE-House green building program.**

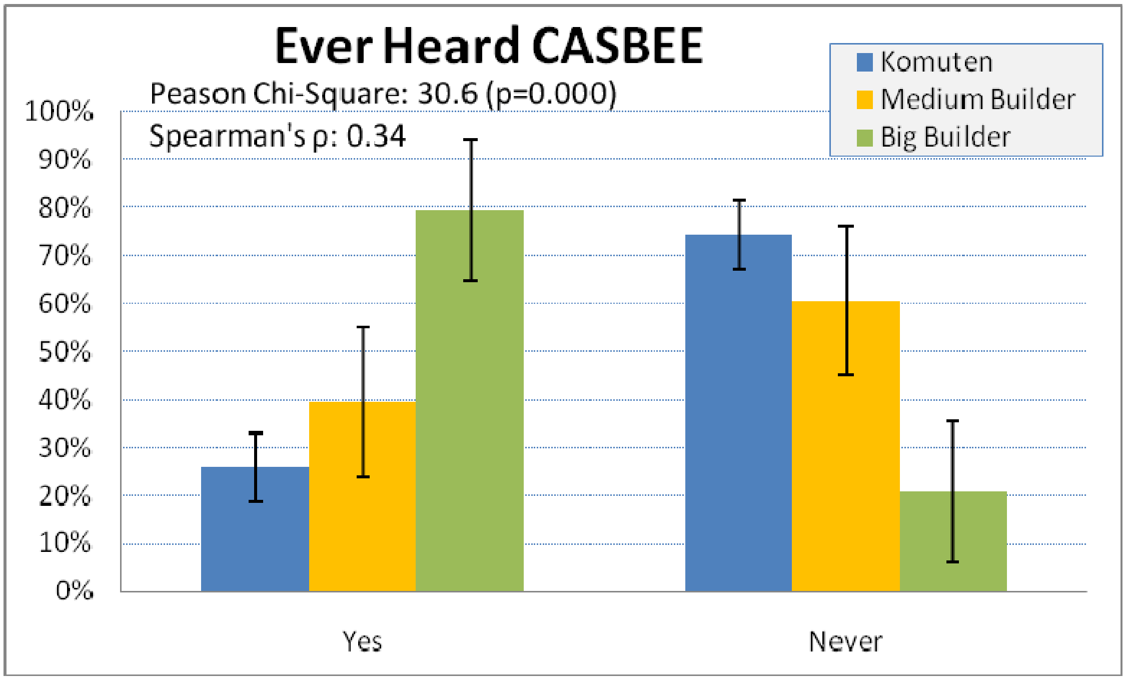


**Figure 8. Comparison of builders awareness of the CASBEE-House green building program, based on firm size.**

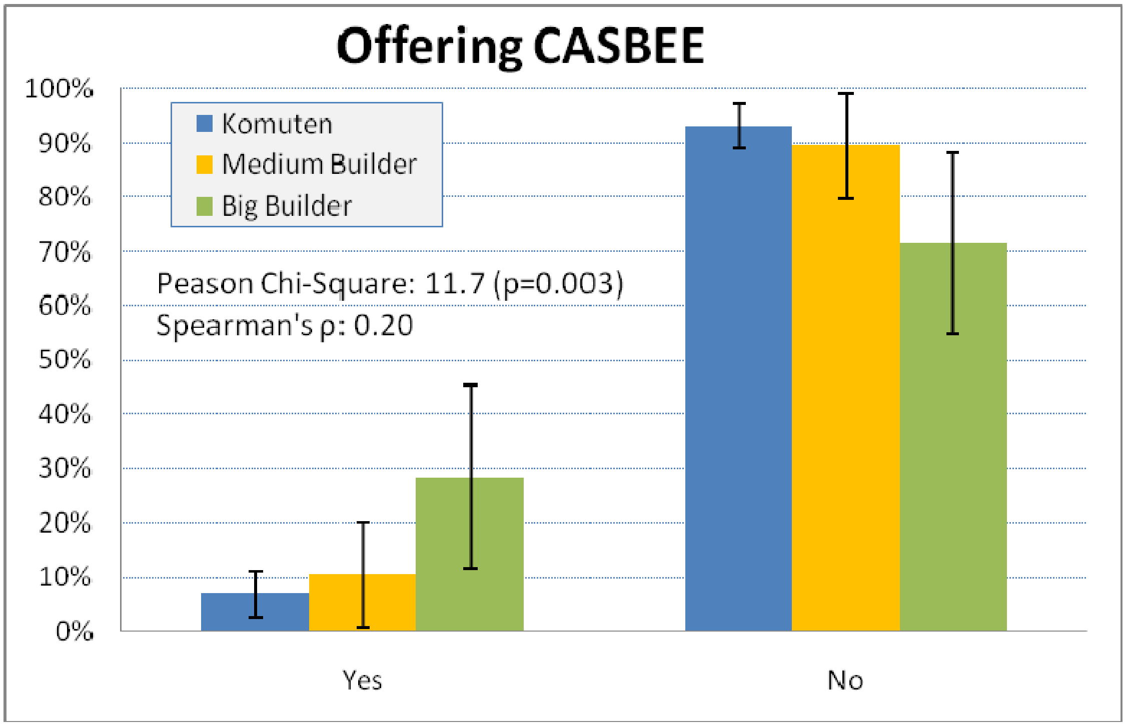


**Figure 9. Comparison of builders use of the CASBEE-House green building program, based on firm size.**

**Awareness and Use of the 200 Year House Program in Japan**

***Architects versus Builders***

Survey respondents were asked about their awareness and use of the 200 Year House building program (Figures 10 and 11). In contrast to the CASBEE-House green building program, builders and architects were much more likely to have heard about, and to have used, the 200 Year House program. Over 90% of builders reported that they had heard about the 200 Year House program and over 45% had used the program. Similarly, 70% of architects were aware of the 200 Year House program although only 14% reported using the program. A statistical analysis of the survey data found that there was a significant different between architects and builders awareness and use of the 200 Year House program.

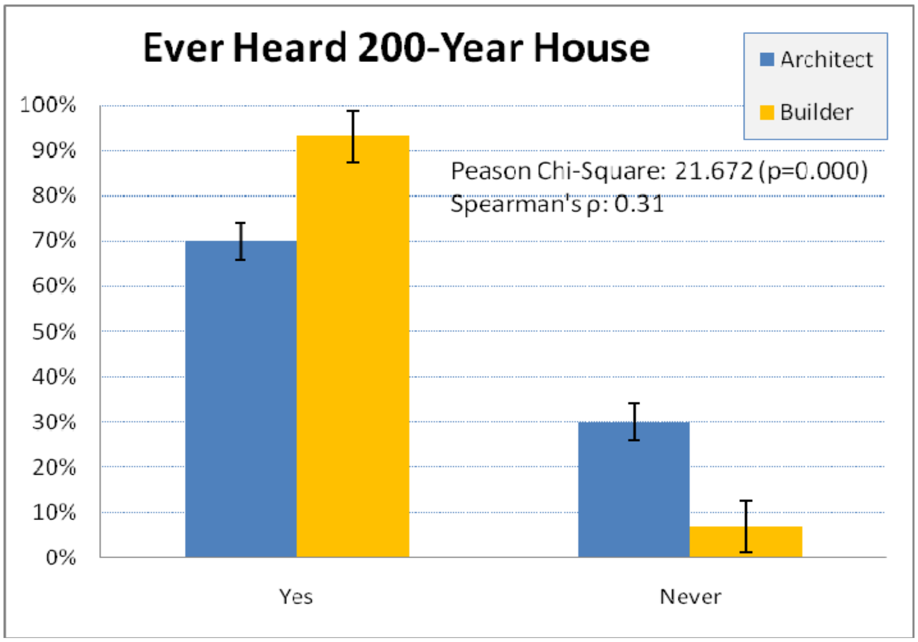


**Figure 10. Comparison of builders and architects awareness of the 200 Year House program.**

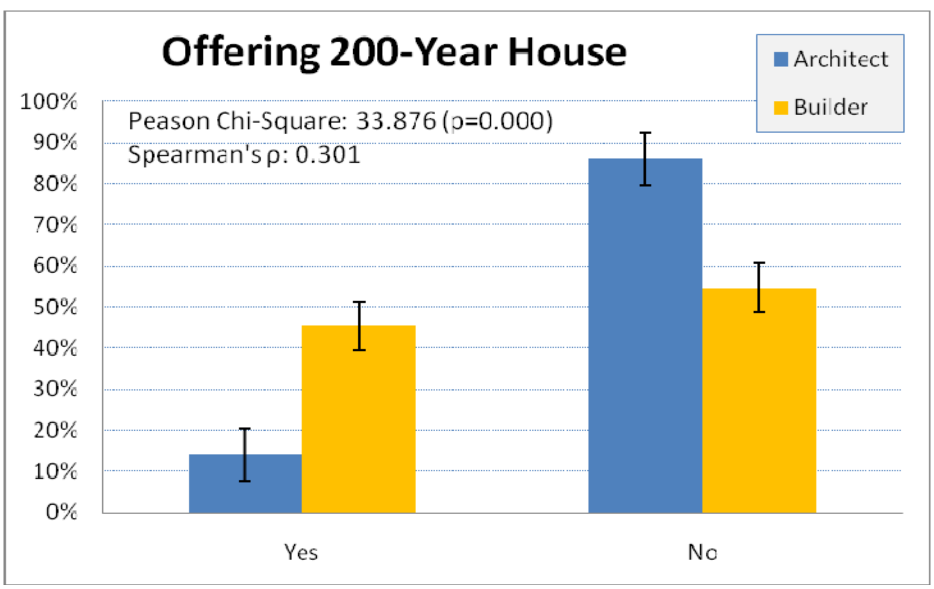


**Figure 11. Comparison of builders and architects use of the 200 Year House program.**

***Large Builders versus Medium-sized Builders and Small Builders (Komuten)***

Virtually all builders reported that they were aware of the 200 Year House program, including all of the large builders surveyed (Figures 12 and 13). The survey data shows that 93.3% of large home builders offer homes under the 200 Year House program, whereas only 47.2% of medium-sized builders and 37.8% of komuten offer homes under the 200 Year House program. A statistical analysis of the survey data found that there were no differences between builders awareness of the 200 Year House program based on firm size, but large builders were significantly more likely to offer homes under the program than small and medium-size builders.

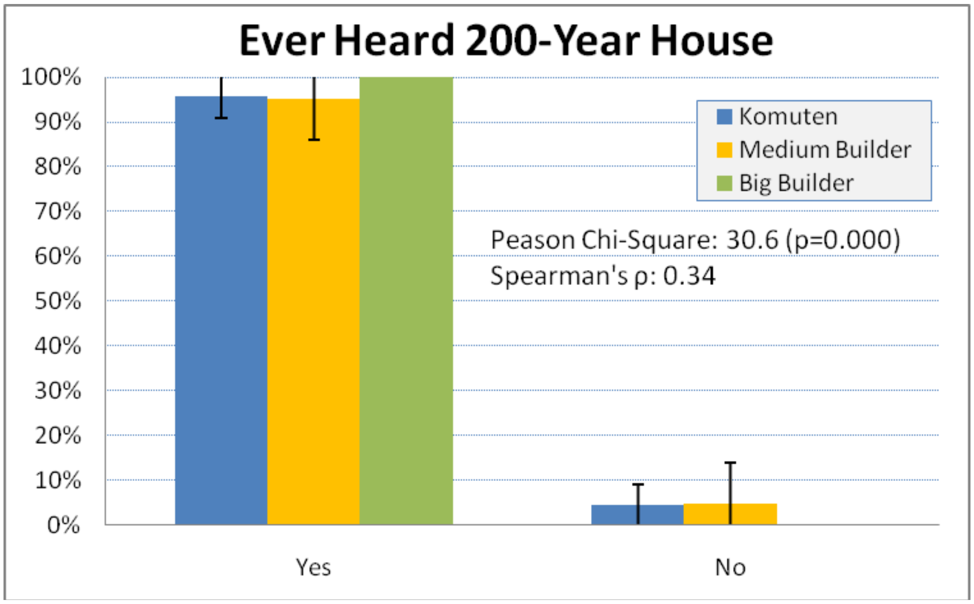


**Figure 12. Comparison of builders awareness of the 200 Year House program, based on firm size.**

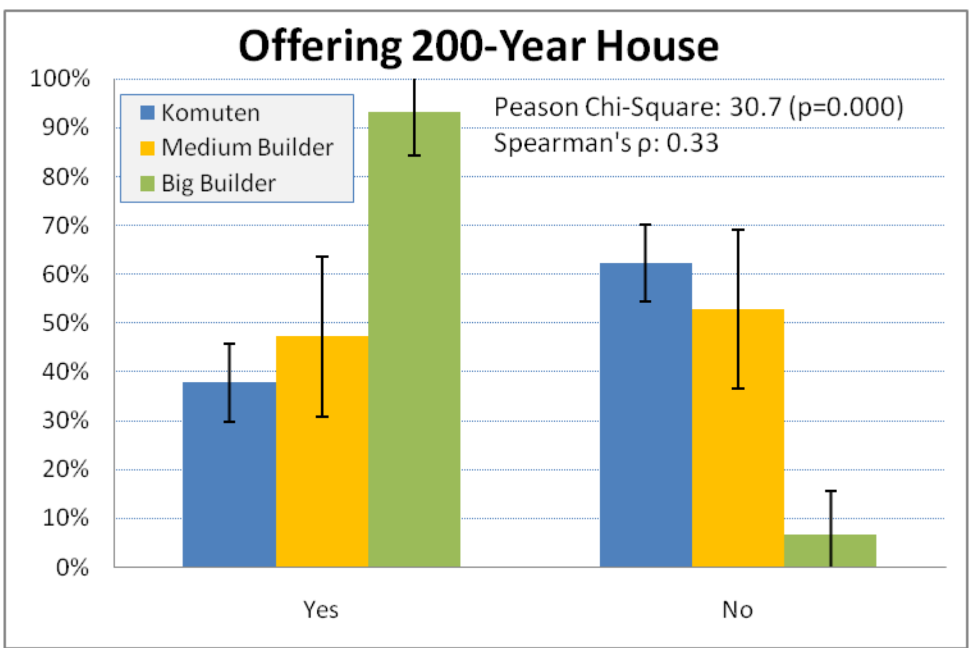


**Figure 13. Comparison of builders use of the 200 Year House program based, on firm size.**

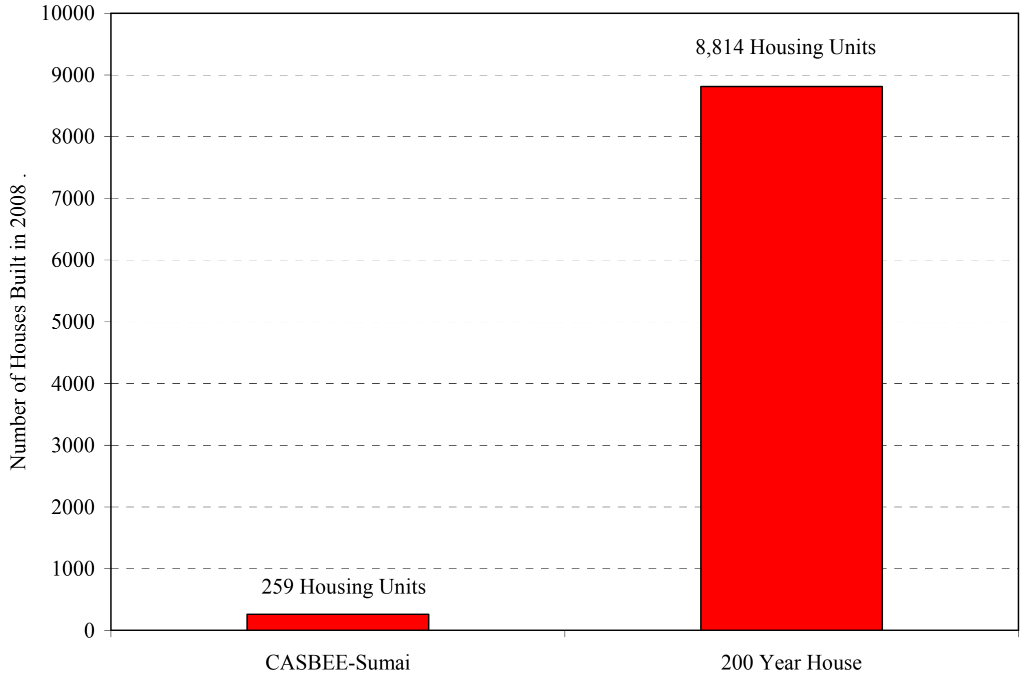


**Figure 14. More houses have been built under the 200 Year House program than CASBEE-House.**

The survey data shows that there is a great disparity in the number of homes built by survey respondents under the two housing programs (Figure 14 and Table 8). Survey respondents reported building 259 houses under the CASBEE-House program compared to 8,814 houses under the 200 Year House program. However, it should be noted that the number of homes built under the 200 Year House program is greatly skewed by the fact that one large home builder reported building 8,000 homes under the program. Interestingly, there have been almost 50,000 housing units approved under the 200 Year House program by the end of 2009. As discussed earlier, large home builders have been more proactive in using both the CASBEE-House and 200 Year House programs than medium-sized builders and small komuten.

**Table 8. Number of homes built under CASBEE-House and the 200 Year Hose Program, by builder size.**

| | Large Builders | Medium Builders | Komuten |
|---|---|---|---|
| **CASBEE-House program** | 225 | 8 | 20 |
| **200 Year House program** | 8544 | 77 | 125 |

## Perceived Effectiveness of Home Building Programs in Japan

After considering their awareness and use of the CASBEE-House green building program and the 200 Year House program, survey respondents were asked several questions regarding their opinions about both programs. In this section of the survey, respondents were asked to give their opinions on the current effectiveness of both programs, customer interest in both programs and the future outlook for both programs. It is important to note at the beginning of this section of the report that approximately half of the respondents had no opinion about the effectiveness of, or the outlook for, CASBEE-House whereas 40% provided no response for the 200 Year House program. In the discussion below, the “Don’t know” responses were removed from the dataset and the analysis was performed on the revised dataset.

### Overall Perceptions on the Current Effectiveness of Building Programs in Japan

Survey respondents clearly perceived that the 200 Year House program has been much more effective than the CASBEE-House green building program. While about half of the respondents reported that both programs have been average in terms of their effectiveness, a sizable gap exists at the extremes. For example, while 30.7% of respondents perceived that the 200 Year House programs was highly effective, just 12.7% felt the same about the CASBEE-House green building program. In contrast, 34.3% of respondents felt that the CASBEE-House program has been ineffective so far while just 17.2% felt the same about the 200 Year House program (Figure 15).

Builders and architects work closely with home buyers and are therefore qualified to provide a unique perspective on home buyers' attitudes towards the CASBEE-House and 200 Year House building programs. In order to get an assessment of home buyers' relative interest in the two programs, home builders and architects were asked to indicate how interested their customers appeared to be in the two different building programs. Survey respondents indicated that home buyer interest in the 200 Year House Program was much higher than for CASBEE-House (Figure 16). Respondents indicated that about a quarter of their customers were highly interested in the 200 Year House program (compared to just 8% for CASBEE-House) whereas almost half of their customer had little interest in the CASBEE-House program (compared to 22.7% for the 200 Year House program).

Finally, respondents were asked to give their opinion on the future outlook for each of the home building programs. Respondents clearly felt that the 200 Year House program has a brighter future, with almost 32% rating the future outlook for the program as being high compared to 18.3% saying it was low (Figure 17). These numbers were reversed for the CASBEE-House green building program with just 19.1% reporting that the future outlook was high compared to 30.1% who felt that the future outlook was low. Approximately half of all respondents felt that the future outlook for both programs was medium.

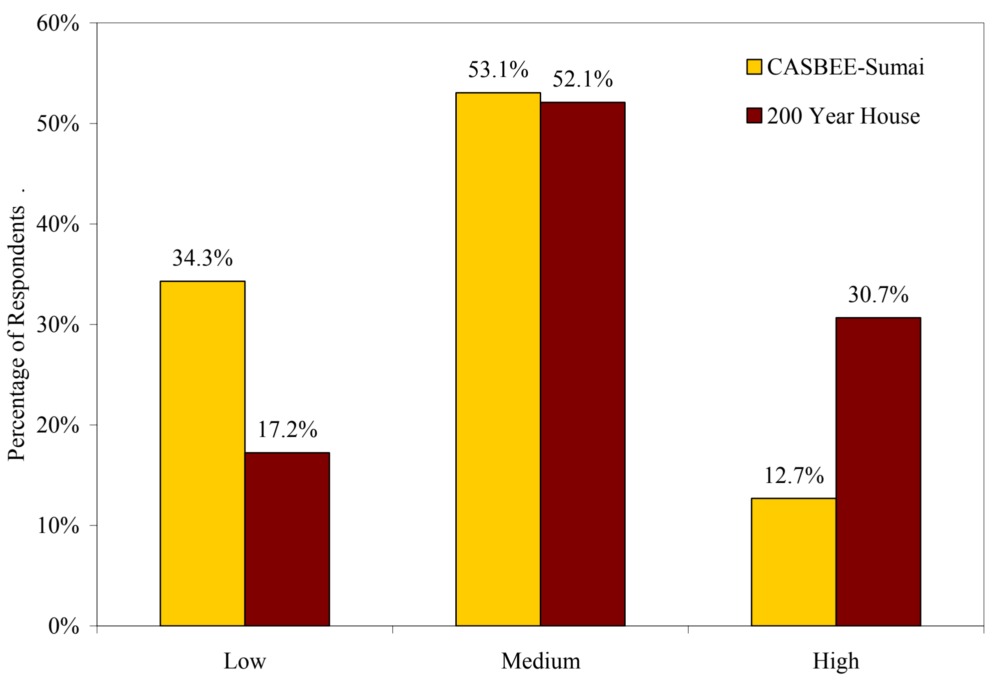


**Figure 15. Survey respondent's perceptions of the current effectiveness of CASBEE-House green building program relative to the 200 Year House program.**

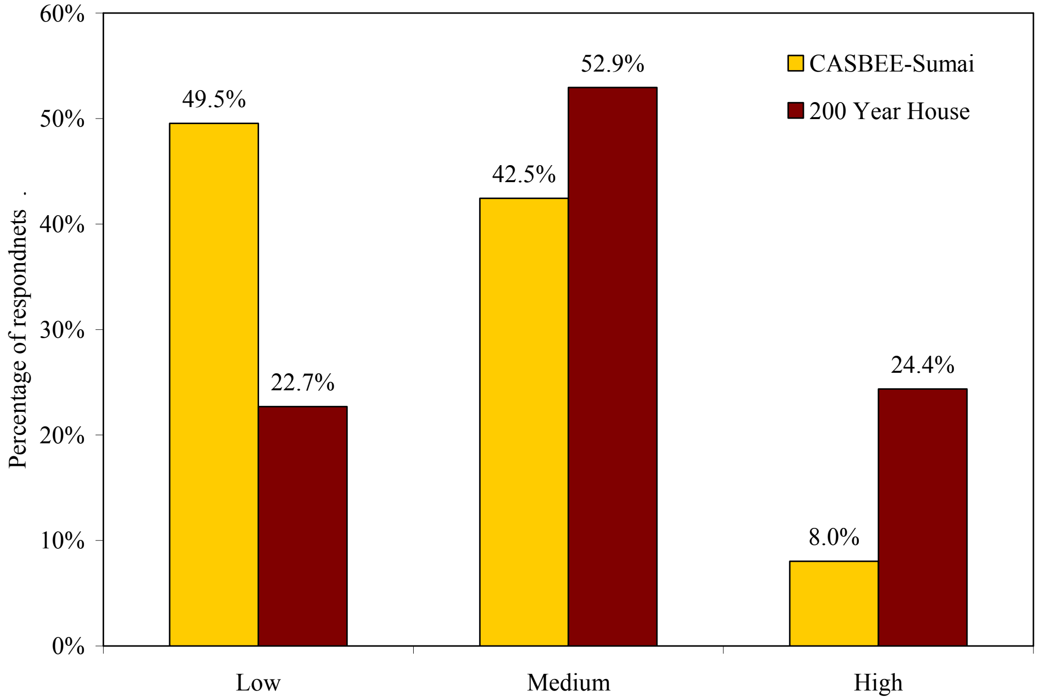


**Figure 16. Survey respondent's perceptions of their customer's interest in the CASBEE-House green building program relative to the 200 Year House program.**

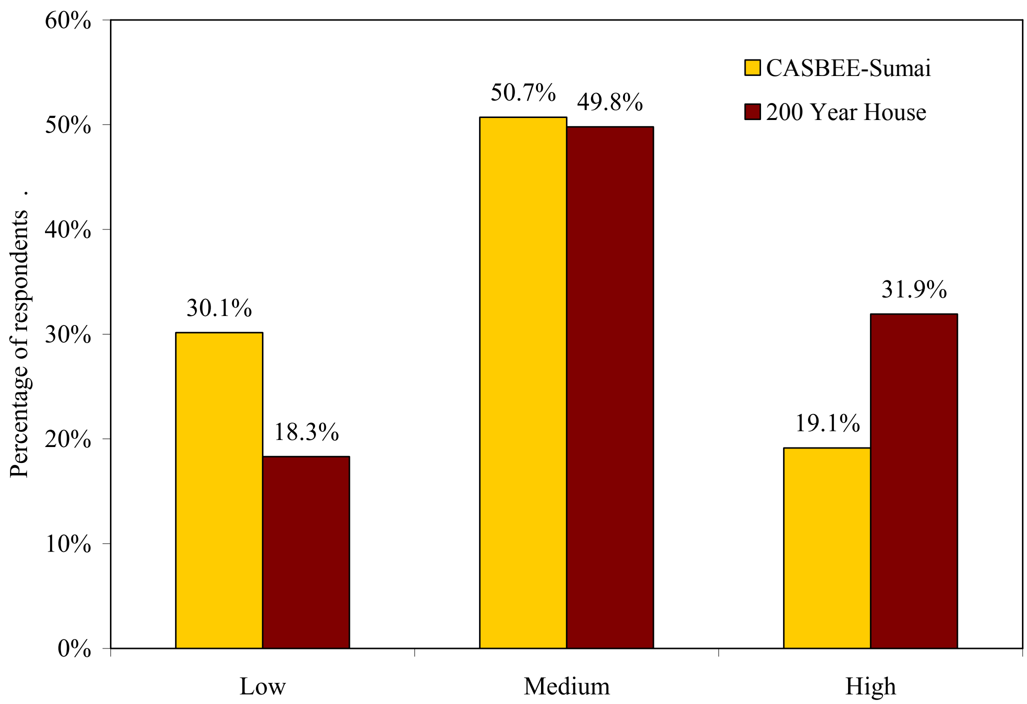


**Figure 17. Survey respondent's perceptions of the future outlook for the CASBEE-House green building program relative to the 200 Year House program.**

***Perceptions of Architects versus Builders***

A shortcoming of the original data is that it does not account for the individual effects where some respondents may have extreme opinions while others may tend to moderate their opinions towards the middle of the scale, an effect which could lead to a bias. In order to overcome this individual effect, we consider the difference between the CASBEE-House and the 200-Year House program scores reported by each respondent. For example, if a respondent provided a current effectiveness rating of medium (2) for the CASBEE-House program and a score of high (3) for the current effectiveness of the 200 Year House program, we calculate that the difference in the scores is a minus one [3 – 2 = -1]. Using this method, we are interested in assessing if the overall effectiveness score between the two building programs is significantly different from zero (which is what the score would be if the effectiveness ratings for both programs were the same). If the overall effectiveness score between the two programs was calculated to be negative, this would indicate that the respondents perceive the 200 Year House program is more effective than the CASBEE-House green building program. Similarly, if the overall effectiveness score was calculated to be positive, this would indicate that the respondents perceive the CASBEE-House green building program is more effective than the 200 Year House program. To test the level of significance between the three categories of program effectiveness (high, medium and low), we use the non-parametric Wilcoxon's signed-rank test.

Overall, 36.9% of respondents perceived that the 200-Year House program has been more effective than CASBEE-House, whereas just 8.6% of respondents think that the CASBEE-House program has been more effective than the 200-Year House program. A statistical analysis of the data showed that both architects and home builders rated the 200-Year House program as being significantly more effective than the CASBEE-House green building program (Figure 18). Respondents were also asked to indicate the level of interest that they felt their customers displayed towards each of the home building programs. The survey results indicate that 37.6% of respondents felt that their customers were more interested in the 200-Year House program than the CASBEE-House green building program. In contrast, just 10.1% of respondents felt that their customers were more interested in CASBEE-House over the 200 Year House program. Overall, the results were significant when the respondents were segmented by architect versus builder (Figure 19). Finally, respondents were asked to give their opinion on the future outlook for each program. The survey results show that 41.2% of respondents felt that the 200-Year House program has a brighter future outlook than the CASBEE-House green building program. Only 4.0% of respondents felt that the outlook was brighter for the CASBEE-House program. For the overall sample, the results were significant when the data was analyzed by type of firm (Figure 20.) These results suggest that most builders and architects perceive that the 200-Year House program has been more effective, has stronger customer support and has a brighter outlook than to the CASBEE-House green building program.

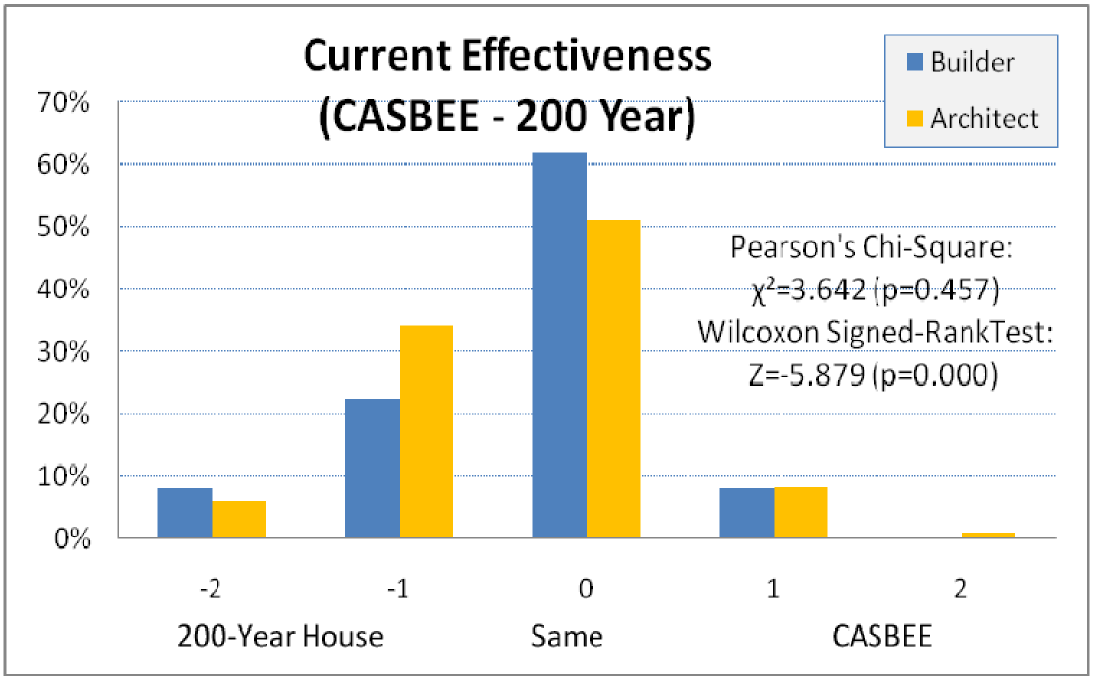


**Figure 18. Survey respondent's perceptions of the current effectiveness of the 200 Year House program relative to the CASBEE-House green building program, by firm type.**

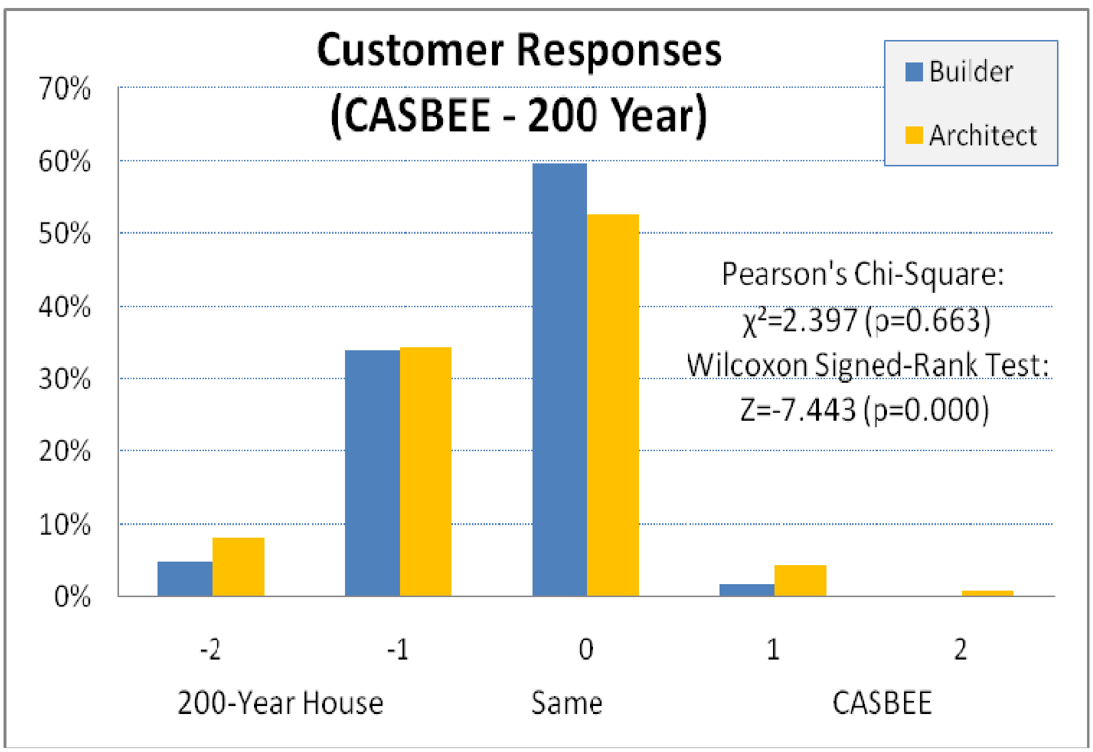


**Figure 19. Survey respondent's perceptions of customer interest in the 200 Year House program relative to the CASBEE-House green building program, by firm type.**

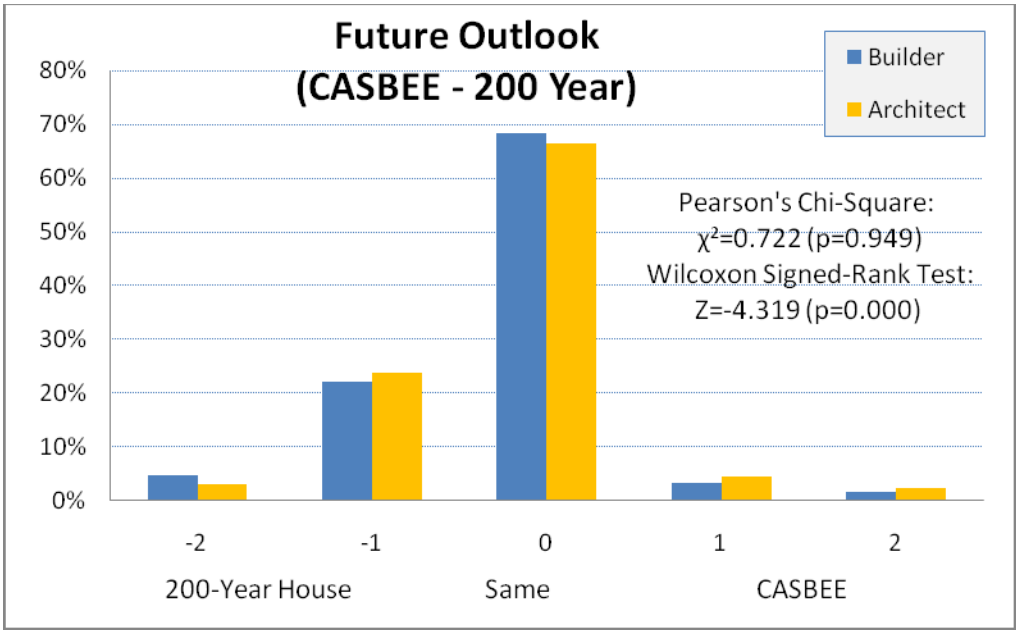


**Figure 20. Survey respondent's perceptions of the future outlook for the 200 Year House program relative to the CASBEE-House green building program, by firm type.**

***Perceptions of Large Builders versus Medium-sized Builders versus Small Builders (Komuten)***

The survey data was also segmented to consider how firm size might affect respondent's perceptions of the effectiveness of the two building programs. Survey respondents were segmented into three firm size categories (large, medium and small) as described previously. When analyzing the data in terms of builder's perceptions of the current effectiveness of the two building programs, it was interesting to note that large home builders were the only group where the vast majority of respondents rated the current effectiveness of CASBEE-House as being medium to high whereas virtually all small and medium-sized builders rated it as being low to medium (Figure 21). In contrast, more than a quarter of respondents in all three groups (and almost a half of the large builders) felt that the current effectiveness of the 200 Year House program was high (Figure 22).

When asked about their customer's interest in the two housing programs, all types of builders reported that they felt that their customers had very little interest in the CASBEE-House green building program whereas almost a quarter of small and medium-sized builders and over 40% of large builders reported that they thought their customers were highly interested in the 200 Year House program (Figures 23 and 24). Finally, builders were a bit more optimistic about how their customers viewed the future of the two programs (Figures 25 and 26). While about a quarter of builders felt that their customers thought the future of the CASBEE-House was high, the numbers were substantially higher when asked about the future of the 200 Year House program.

These results tend to support the trends observed in the previous sections. Builders tend to have a much more favorable perception of the current and future effectiveness of the 200 Year House program than they do for the CASBEE-House green building program. In particular, small and medium sized builders have low opinions of the CASBEE-House green building program. Similarly, builders and architects both feel that their customers are much more interested in the 200 Year House program, with few builders reporting that their customers had a high degree of interest in the CASBEE-House green building program. It would be useful to determine what factors have limited building professionals and consumers awareness of CASBEE-House and are negatively affecting their perceptions of the program.

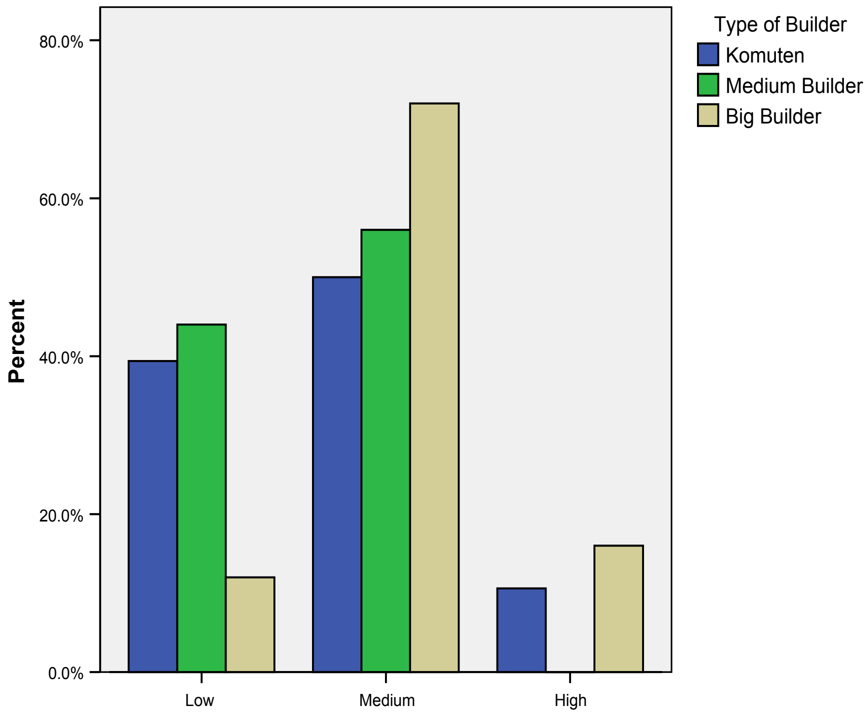


**Figure 21. Survey respondent's perceptions of the current effectiveness of the CASBEE-House green building program, by firm size.**

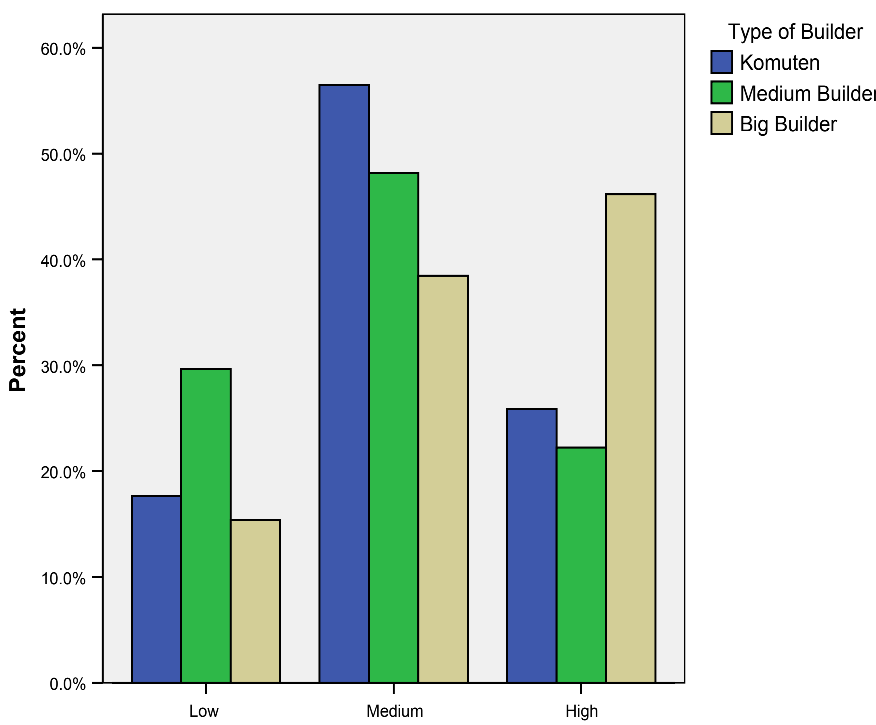


**Figure 22. Survey respondent's perceptions of the current effectiveness of the 200 Year House program, by firm size.**

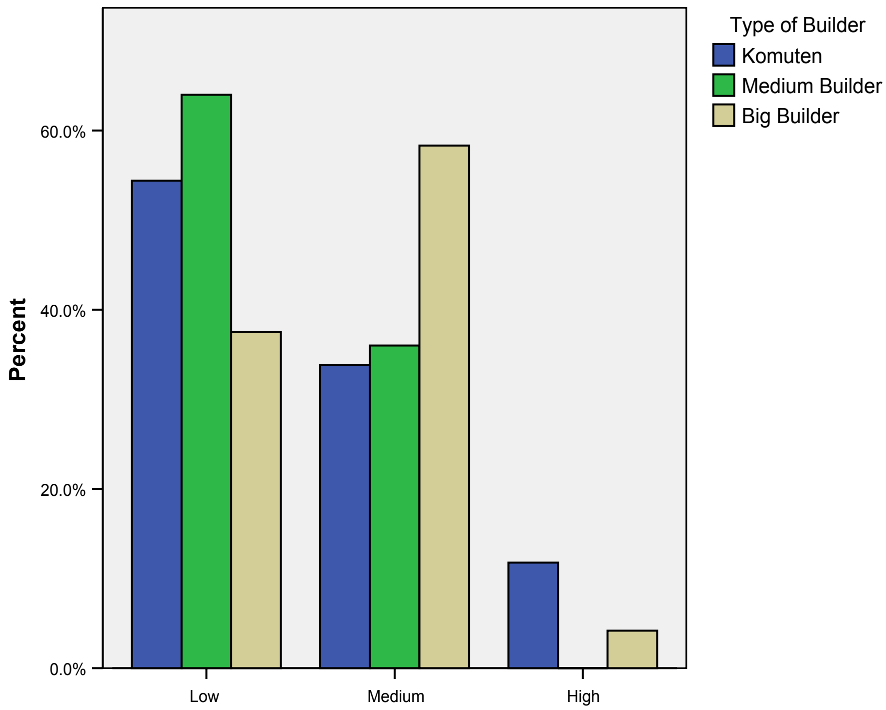


**Figure 23. Survey respondent's perceptions of customer interest in the CASBEE-House green building program, by firm size.**

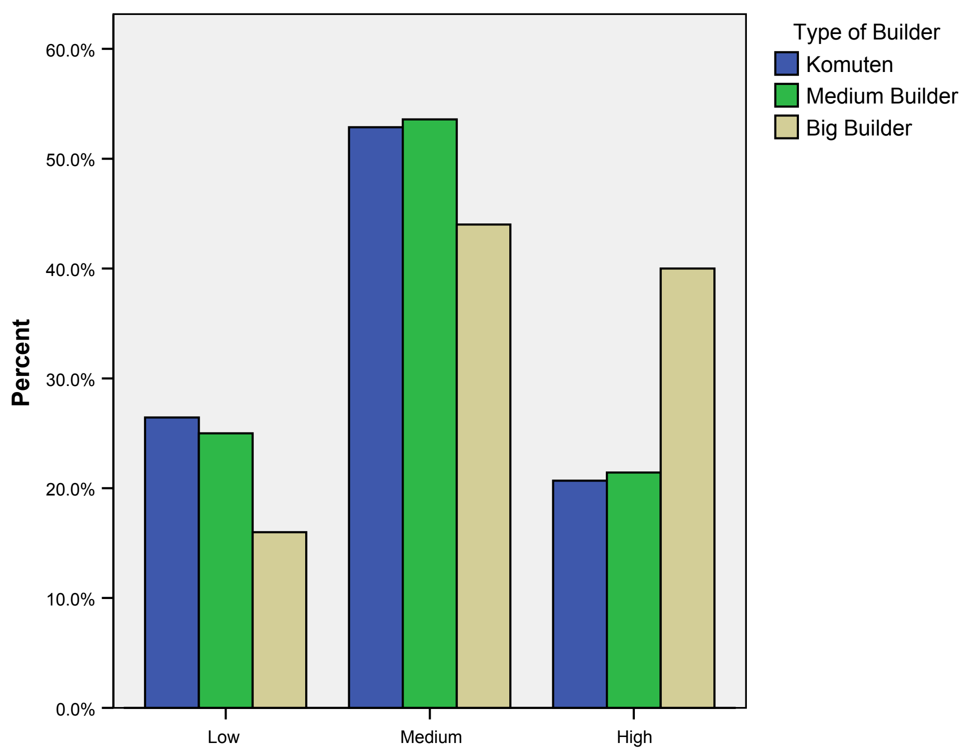


**Figure 24. Survey respondent's perceptions of customer interest in the 200 Year House program, by firm size.**

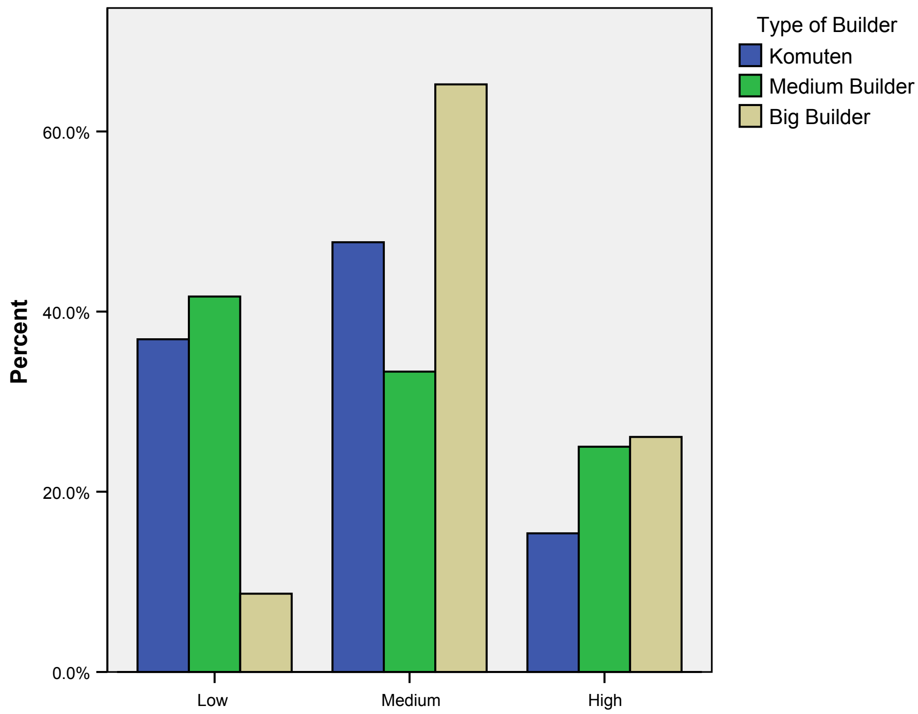


**Figure 25. Survey respondent's perceptions of the future outlook for the CASBEE-House green building program, by firm size.**

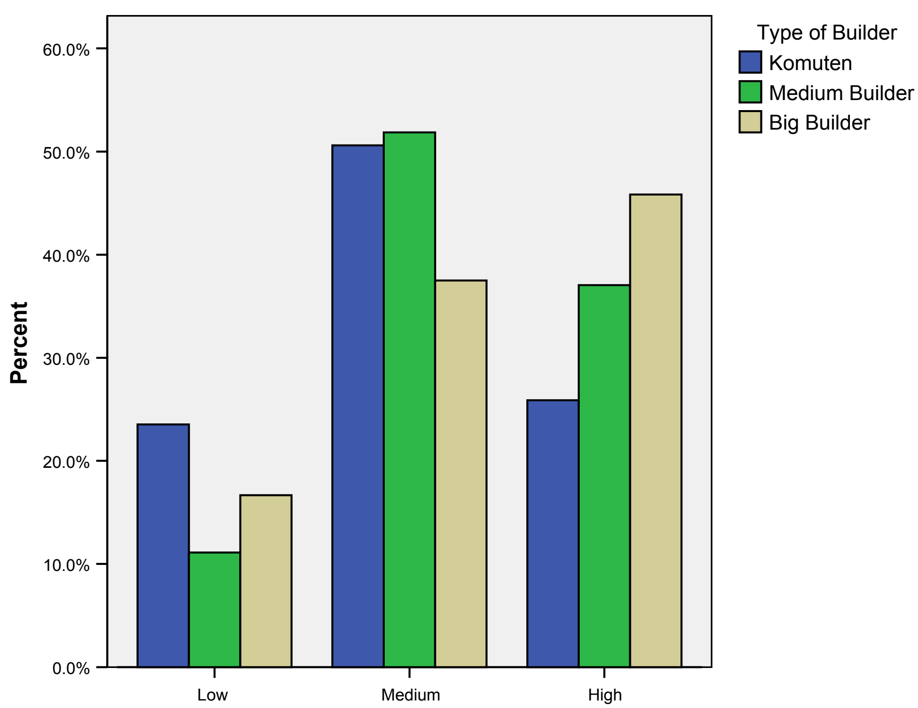


**Figure 26. Survey respondent's perceptions of the future outlook for the 200 Year House program, by firm size.**

**Perceived environmental performance of wood versus steel versus concrete**

This survey was also designed to gain insights into respondent's perceptions of the relative environmental performance of the three major structural building materials used in Japan (wood, steel and concrete) along a number of performance measures. The environmental performance measures used in the study included: energy use during manufacturing of the raw materials, pollution generated during manufacturing of the raw materials, $CO_2$ emissions during the manufacturing of the raw materials, energy efficiency of the completed house, sustainability of the three structural building materials and the overall environmental friendliness of each structural building material.

One of the consistent shortcomings of most green building programs is their failure to account for the total life cycle impacts of the different structural materials used to build a house. By ignoring these impacts, green building programs often negatively influence the material selection process by encouraging the use of less environmentally friendly building materials. If green building programs were to give full consideration to the entire life cycle of building materials, they would force builders and architects to consider the often substantial environmental degradation associated with the mining and manufacturing of specific primary structural building materials. In this section of the research, Japanese builders and architects were asked to provide their assessment of the relative environmental performance of wood, steel and concrete as a structural building material in residential construction.

***Total environmental score (TES) of structural building materials***

In this section of the report, we will make reference to the total environmental score (TES) for each building material along each of the environmental performance measures. The TES score provides a simple method of summarizing the perceptions of builders and to provide a comparative ranking of each of the building materials relative to the others. The TES scores were calculated by using a simple weighting of the number of respondent who selected each rating for each material on each performance measure. The weighting method selected awarded 3 for a high environmental score, a 1 for a medium environmental score and zero for a low (poor) environmental score. The zero weighting for the low score was based on the premise that materials with a low environmental score should be penalized (with a zero weighting) because of their poor environmental performance. To illustrate the process of calculating a TES, consider the respondents ratings of the energy use during the lumber manufacturing process. In this case, 200 respondents rated energy use during the manufacturing process as being low, 132 respondents rated it as being medium and 37 respondents rated it as being high. The TES score for the energy use of wood during the manufacturing process is calculated as:

$$\text{TES} = 3(200) + 1(132) + 0(37) = 732$$

The full range of TES scores are presented in Figure 27 and Table 9. The results of the survey data clearly show that Japanese building professionals perceive wood to be the most environmentally friendly structural building material across all six of the environmental performance measure included in the survey. In contrast, steel is perceived as being the least environmentally friendly structural building materials across most of the environmental performance measures, with the exception of "sustainability of the resource".

**Table 9. Total environmental scores for wood, steel and concrete across each environmental measure.**

| | Wood | Concrete | Steel |
|---|---|---|---|
| Low energy use during manufacturing | 732 | 246 | 135 |
| High sustainability of resource | 527 | 367 | 415 |
| Low pollution during manufacturing | 896 | 333 | 255 |
| High energy efficiency of completed house | 726 | 413 | 277 |
| Low $CO_2$ emissions during manufacturing | 666 | 251 | 174 |
| High overall environmental friendliness | 895 | 271 | 271 |

Note: scoring is 3 for high score, 1 for middle score and 0 for low score

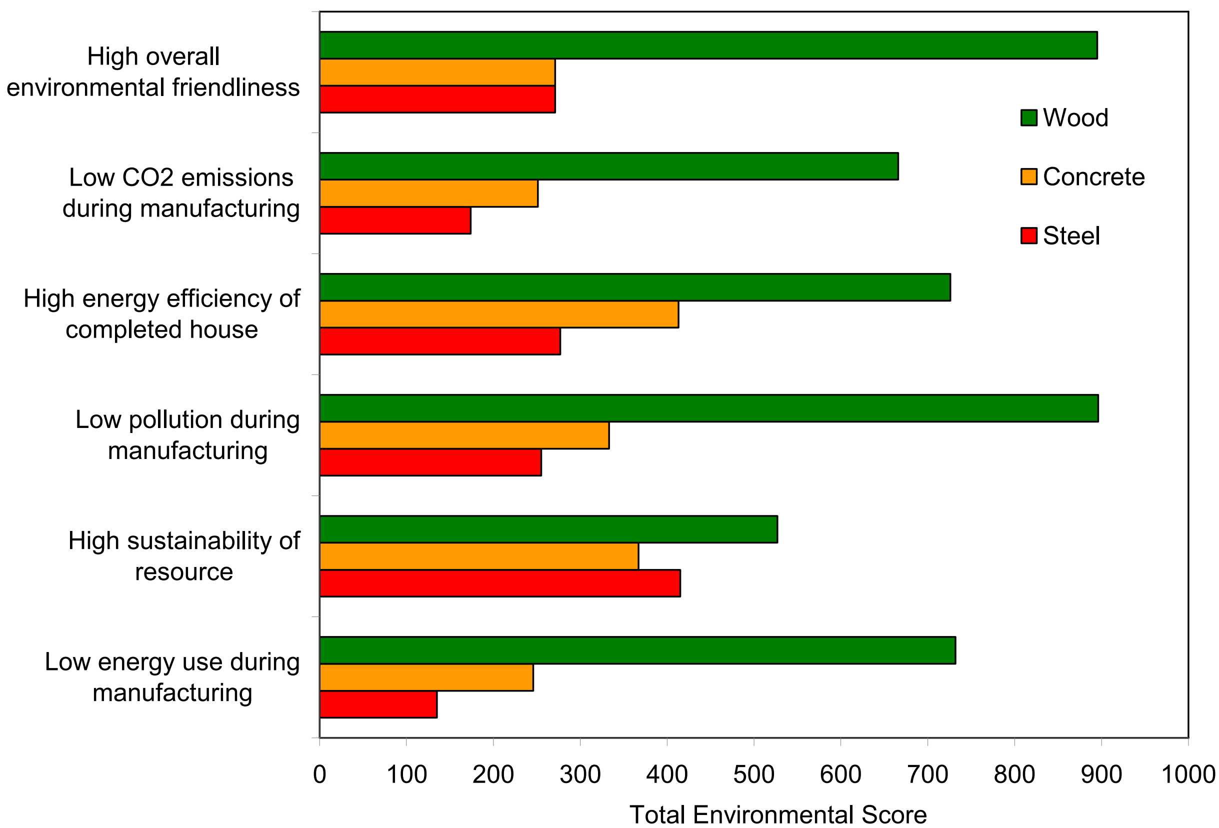


**Figure 27. Total environmental scores for structural building materials across six environmental performance measures.**

***Perceived relative environmental performance of structural building materials***

More than half of Japanese building professionals (54.2%) perceived that wood had the lowest energy use during its manufacturing process while less than 10% of respondents felt that either steel (6.2%) or concrete (7.6%) had the lowest energy use during manufacturing, Figure 28. In contrast, just 10% of respondents felt that wood had the highest energy use during manufacturing while 46.1% though that concrete had the highest energy use and 74.3% thought that steel had the highest energy use. Combining the percentages of low and medium energy use scores for each material shows that wood (54.2% + 35.8% = 90%) is clearly viewed as being superior to either concrete (53.9%) or steel (25.7%) in terms of the amount of energy used during the manufacturing process.

A similar result was found for the amount of pollution generated during the manufacturing process as well as the amount of $CO_2$ emitted during the manufacturing process, Figures 29 and 30. Almost three-quarters of respondents reported that wood generated the lowest amount of pollution during manufacturing (compared to 13.1% for concrete and 11.9% for steel) while the composite score obtained by combining the low and medium scores for wood was 93% of respondents (compared to 68.5% for concrete and 48.4% for steel). When asked about $CO_2$ emissions during manufacturing almost half of the respondents reported that wood was lowest (compared to 7.4% for concrete and 6.6% for steel) while the composite score obtained by combining the low and medium scores for wood was 88.3% of respondents (compared to 56.5% for concrete and 36.6% for steel).

Japanese building professionals clearly perceive wooden homes as being significantly more energy efficient than either steel or concrete homes, Figure 31. Over 55% of respondents reported that wooden homes had high energy efficiency while over 90% perceived wooden homes as having either high or medium energy efficiency. In contrast, only 22.1% of respondents felt that concrete homes were highly energy efficient while only 8.5% felt that steel homes were highly energy efficient. The combined scores for high and medium energy efficiency were 90.3%, 75.9% and 63.9% for wood, concrete and steel homes, respectively.

Finally, respondents were asked to rate the sustainability as well as the overall environmental friendliness of each structural building material, Figures 32 and 33. As seen with the previous environmental measures, a statistically higher proportion of survey respondents reported that wood was both the most sustainable of the three building materials (35.2% for wood vs. 15.2% for concrete and 20.7% for steel) as well as being the most environmentally friendly (74.1% for wood vs. 6.6% for concrete and 8.4% for steel). Combining the high and medium scores for each material further emphasized the perceived environmental superiority of wood in terms of resource sustainability and environmental friendliness.

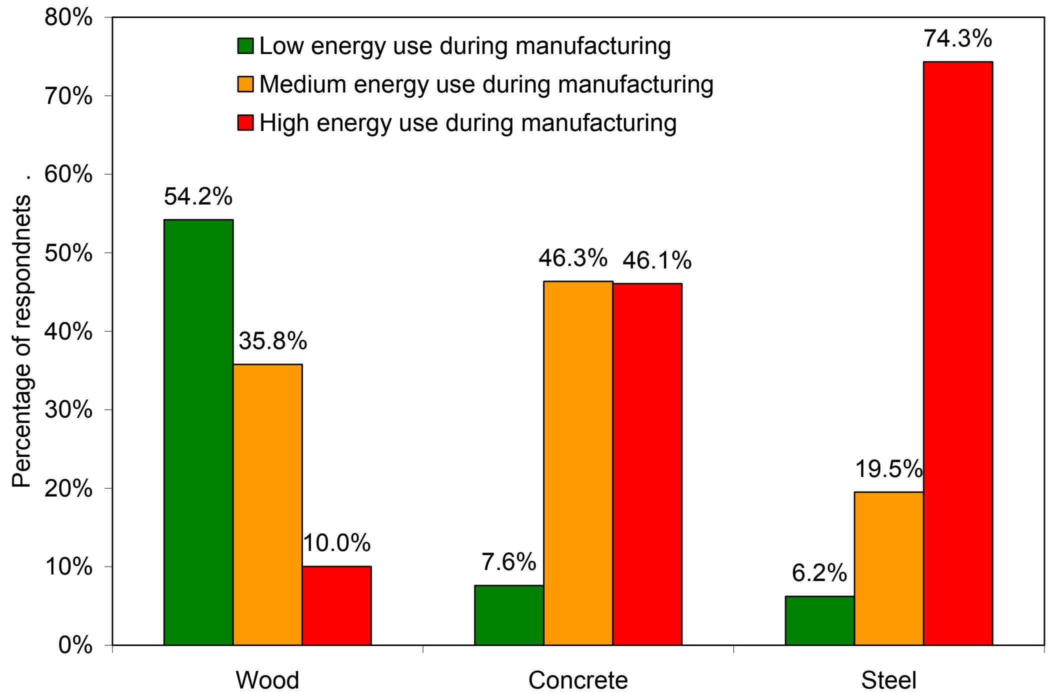


**Figure 28. Respondent's perceptions of the relative energy use during the manufacturing process for wood, steel and concrete.**

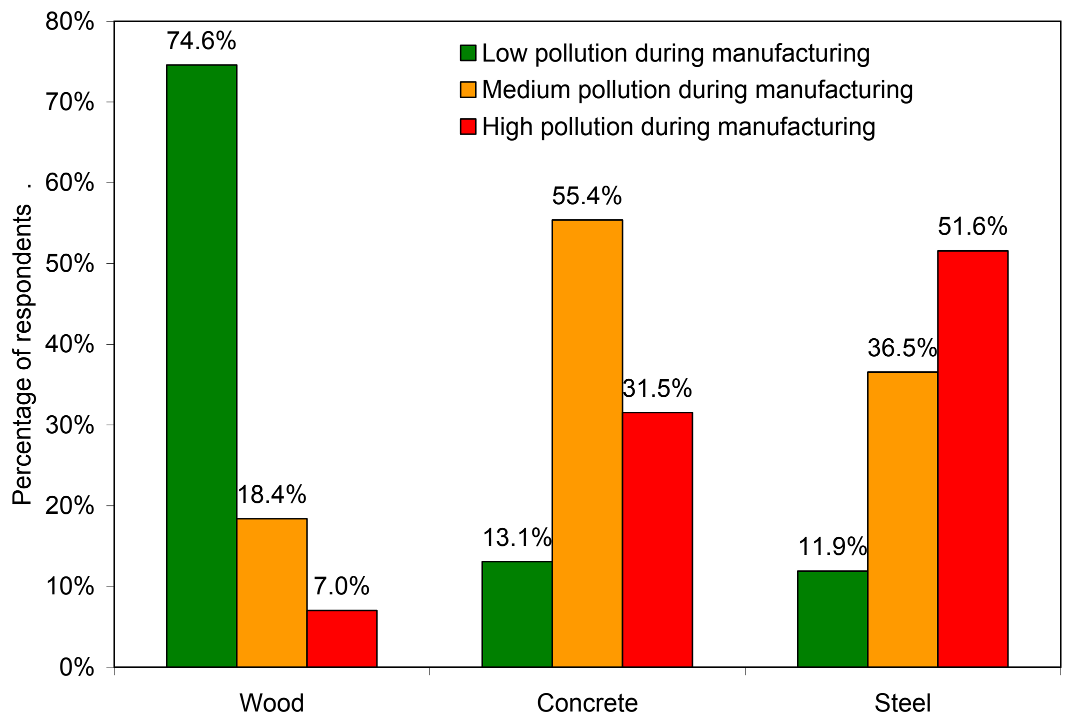


**Figure 29. Respondent's perceptions of the level of pollution generated during the manufacturing process for wood, steel and concrete.**

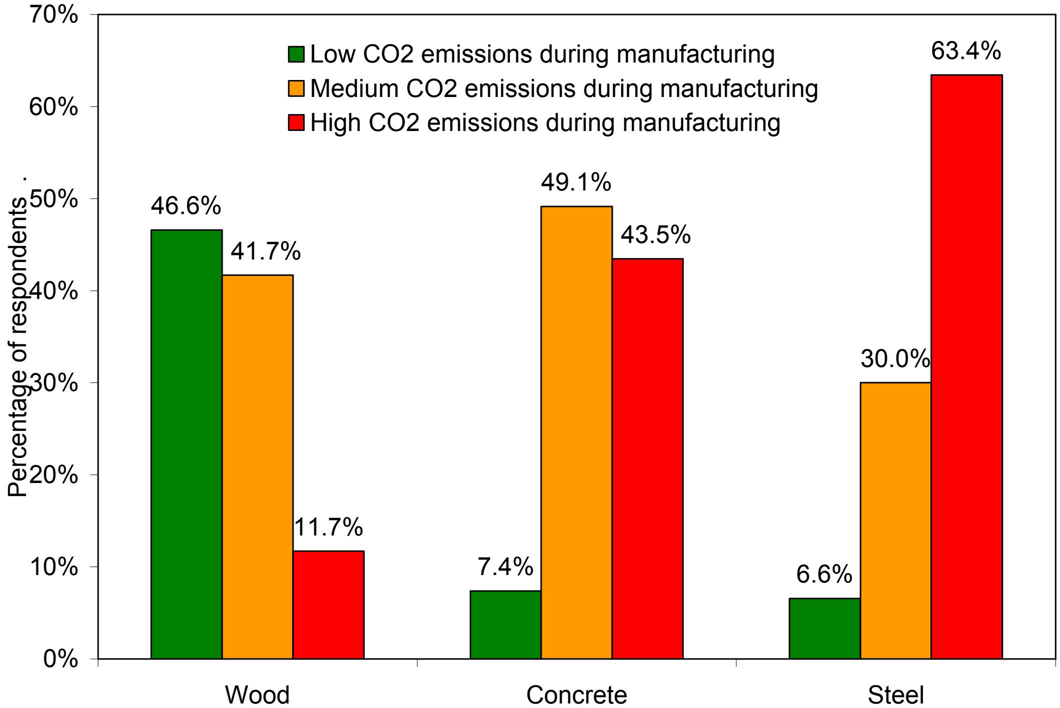


**Figure 30. Respondent's perceptions of the relative level of $CO_2$ emissions during the manufacturing process for wood, steel and concrete.**

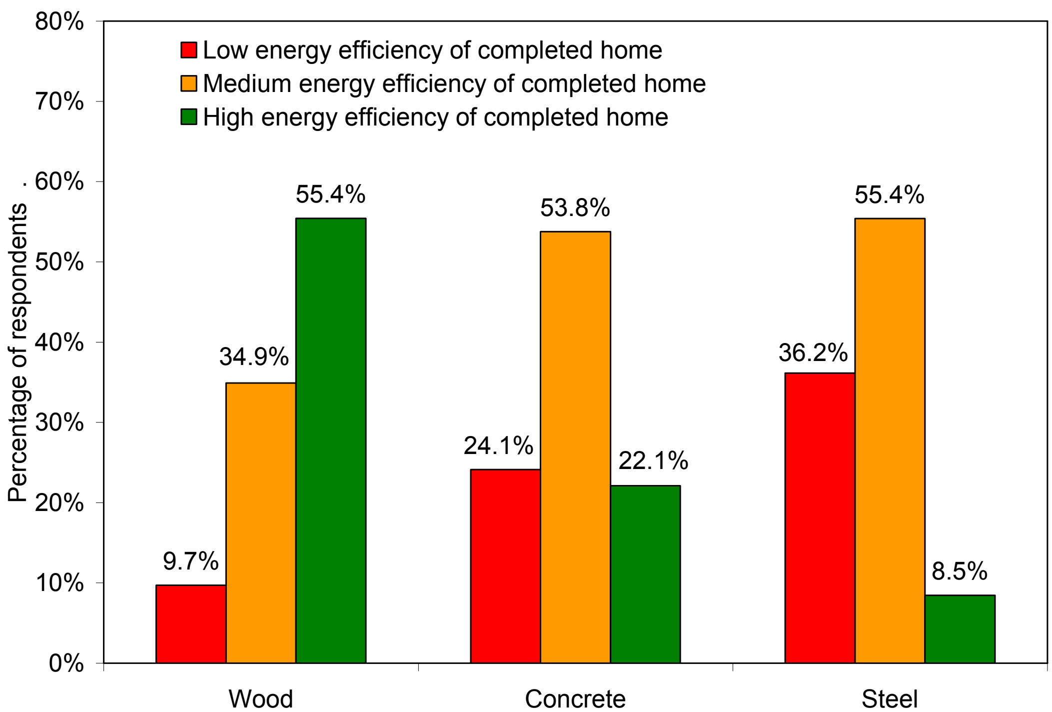


**Figure 31. Respondent's perceptions of the relative energy efficiency of a home built using wood, steel and concrete as the structural building material.**

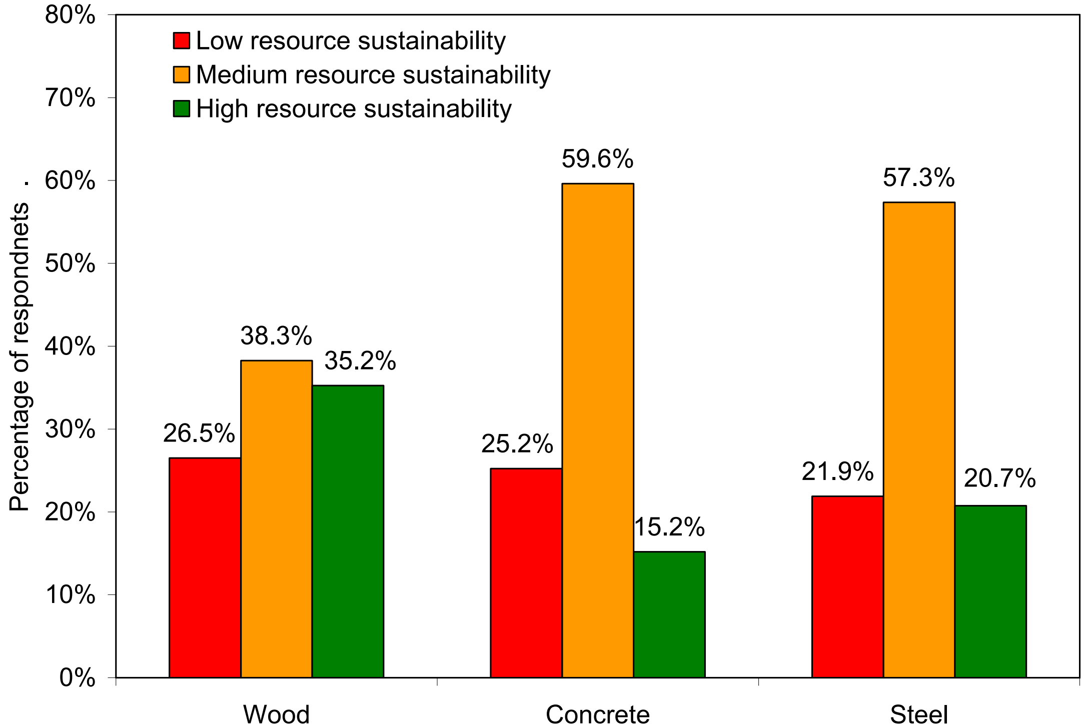


**Figure 32. Respondent's perceptions of the relative resource sustainability for wood, steel and concrete.**

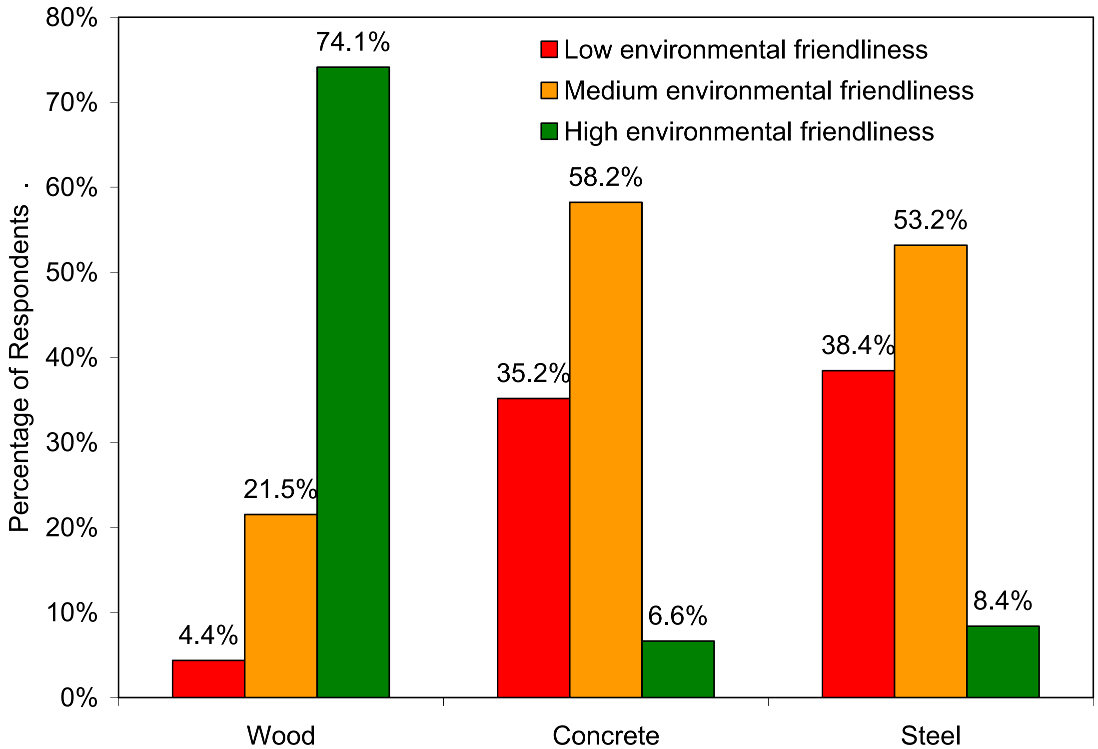


**Figure 33. Respondent's perceptions of the relative environmental friendliness of structural building materials manufactured from wood, steel and concrete.**

### *Normalizing the environmental performance dataset*

As discussed in the previous section, we would like to minimize individual biases in the way respondents answer questions. Since the initial values were expressed using an ordinal scale, and our interest is to compare the respondent's environmental perceptions of each of the three building materials, a standard score (z-score) was calculated for each category. This method allows us to effectively reduce or eliminate individual effects (e.g. the tendency for some people give higher scores for all items, whereas others give lower scores for all items). By doing this, we force the dataset to comply with a normal distribution which allows us to apply a one-way ANOVA to compare the differences in the means for each structural material.

Respondents perceived that each material required a significantly different level of energy consumption during the manufacturing process, Table 10, Figure 34. Similarly significant results were obtained across all of the materials considered, where wood was perceived to be significantly better than both steel and concrete across all of the environmental performance measures. Referring to steel and concrete, both materials were perceived as being fairly similar in terms of the various environmental performance measures.

In summary, most building professionals in Japan perceive wood housing as having superior environmental performance compared to steel and concrete houses. Lumber was perceived as being significantly more environmentally friendly than both steel and concrete. The results of the post-hoc test do not show a significant difference between the perceived relative environmental performance of steel and concrete.

**Table 10. Wood is perceived as being significantly better than steel and concrete in terms of its environmental performance across all six measures.**

| One-Way ANOVA | F-test | Sig. |
|---|---|---|
| Energy use during the manufacturing process | 446.3 | 0.000 |
| Pollution generated during the manufacturing process | 476.9 | 0.000 |
| $CO_2$ emissions during the manufacturing process | 364.1 | 0.000 |
| Sustainability of the resource | 12.80 | 0.000 |
| Energy efficiency of the completed house | 160.3 | 0.000 |
| Overall environmental friendliness of the structural material | 577.3 | 0.000 |

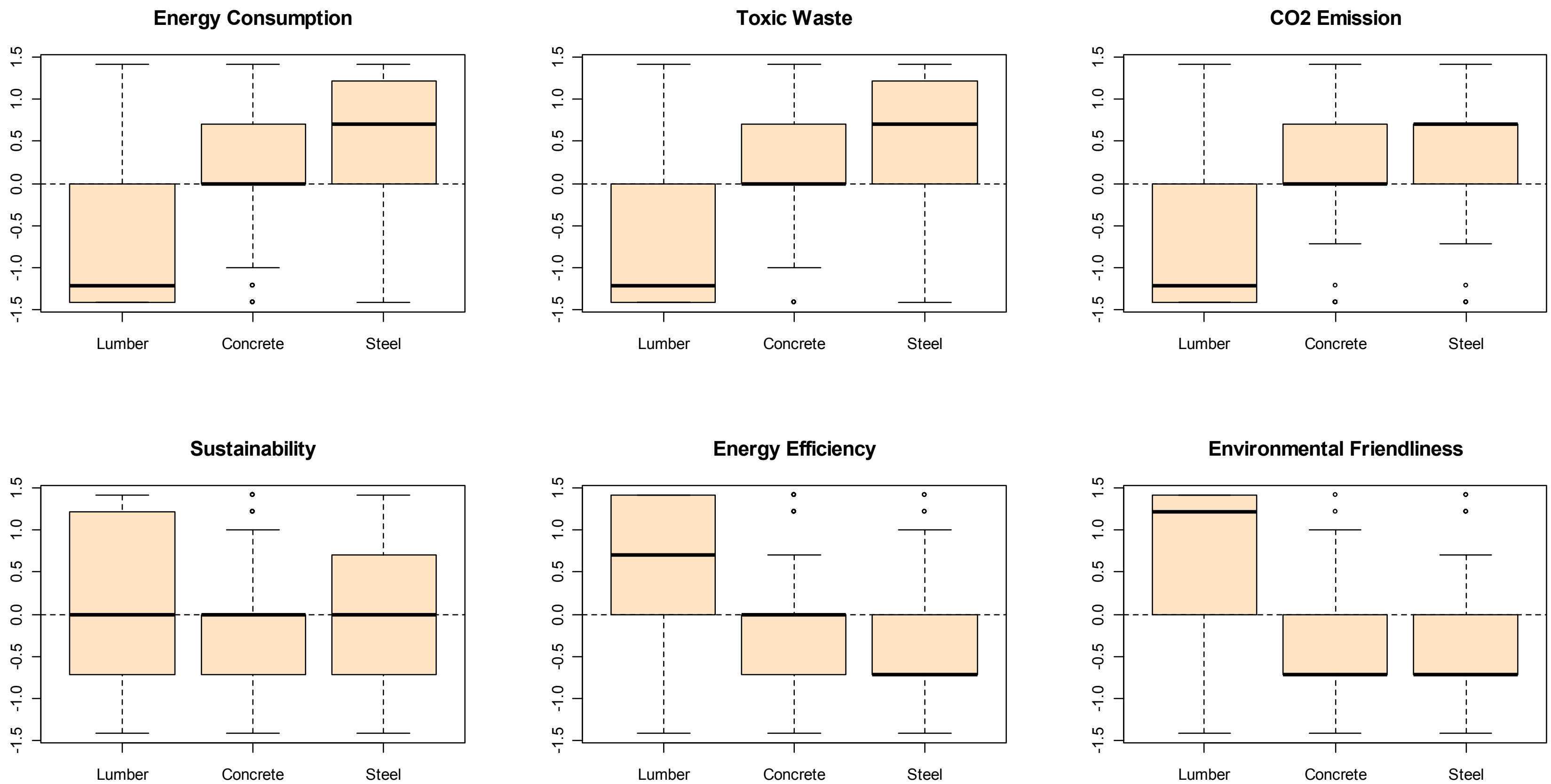


**Figure 34. Respondent's perceptions of the relative environmental performance of wood, steel and concrete as a structural building material show that wood is perceived to be superior to both steel and concrete.**

**Perceived importance of environmental attributes**

Builder and architects tend to prioritize environmental attributes, much the same way that they do with structural performance attributes and other types of performance attributes. The relative importance of the attributes tends to influence, either consciously or unconsciously, their material specification decisions as well as purchase decisions. This is particularly important where building professionals, working with green building programs, change the way they select building materials in order to maximize the environmental rating of the house being designed or built. Therefore, it is important to understand which environmental attributes are considered to be important when they are evaluating alternative building materials and also to understand how building professionals perceive how the relative environmental performance compares for each building material. Attributes that are perceived to be most important in gaining points within a green building program often tend to have the greatest impact on influencing material specification and purchase decisions. Previous research and discussions with construction professionals in Japan and China suggest that the most important environmental performance attributes tin both countries include: 1) energy efficiency, 2) water savings, 3) using recycle materials, 4) using renewable materials, and 5) reducing $CO_2$ emissions. Based on the commonality of builders and architects perceptions, these attributes were included in the survey.

In order to evaluate the relative importance of these environmental attributes for building professionals in Japan, respondents were asked to rate the importance of each environmental performance attribute using a five-point Likert-like scale, where a rating of 1 = Not important at all, 2 = Not important, 3 = Neutral, 4 = Important and 5 = Very important. The average importance ratings for each of the environmental attributes are presented in Figure 35. "Energy efficiency of the house" was found to be the most importance environmental attribute and it was rated as being significantly more important than all of the other attributes. The second most important environmental attribute, "Using water saving appliances and fixtures", was rated significantly higher than the other environmental attributes with lower ratings. There was no significant difference in the importance ratings for the environmental attributes "Low carbon footprint" and "Uses renewable raw materials", although both were rated as being significantly more important than the lowest rated environmental attribute, "Uses recycled materials. "

As was done in previous sections, a standardized score (z-score) was calculated for each environmental attribute. In doing this, we transform the dataset towards a normal distribution which allows us to apply a one-way ANOVA statistical test to compare the differences in the means between the environmental attributes. The results (Figure 36) provide an alternative way of viewing the information presented in Figure 35. In addition, the importance ratings were segmented by firm type (builder versus architect) to see if there were significant differences in the importance ratings between the two groups. The results of the statistical analysis show that the relative importance ratings for each group were the same and that the only statistically significant difference between the two groups was with respect to the environmental attribute "water saving appliances and fixtures", which was rated as being significantly more important by architects (Figures 37 and 38).

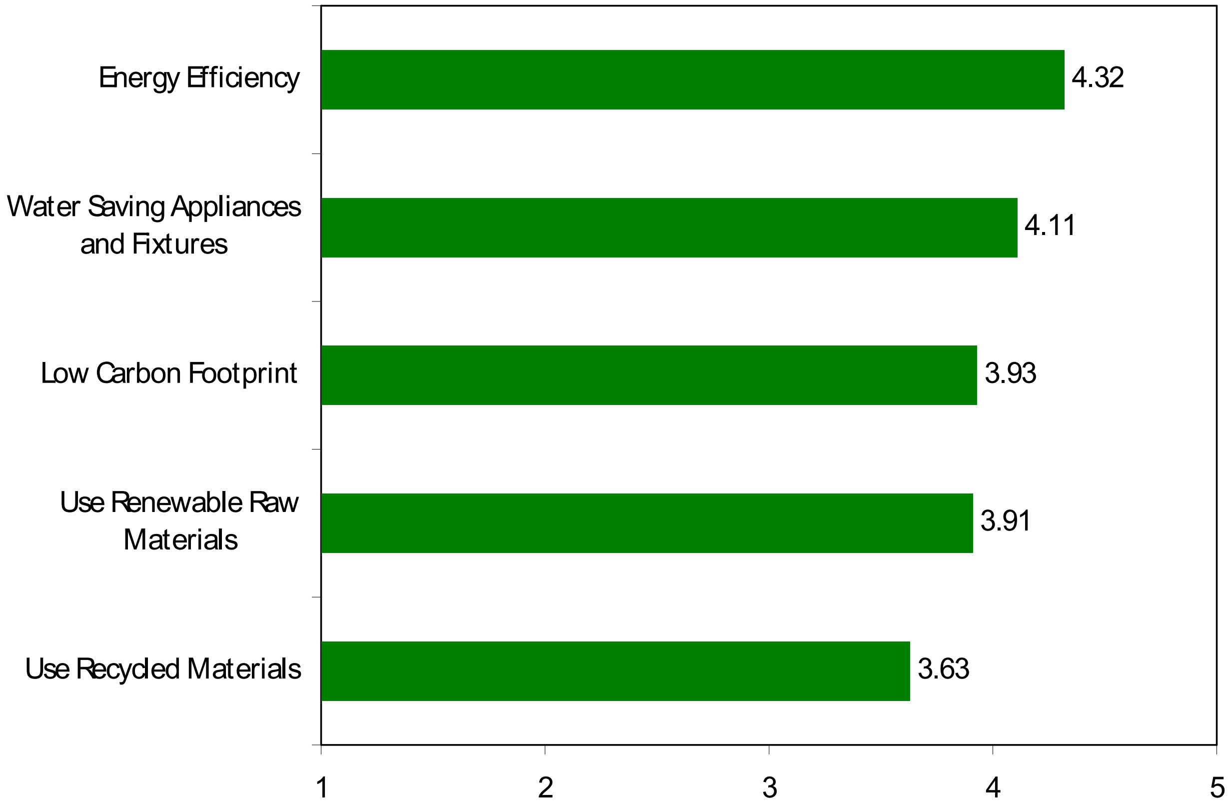


**Figure 35. Summary of the average importance ratings for the environmental attributes.**

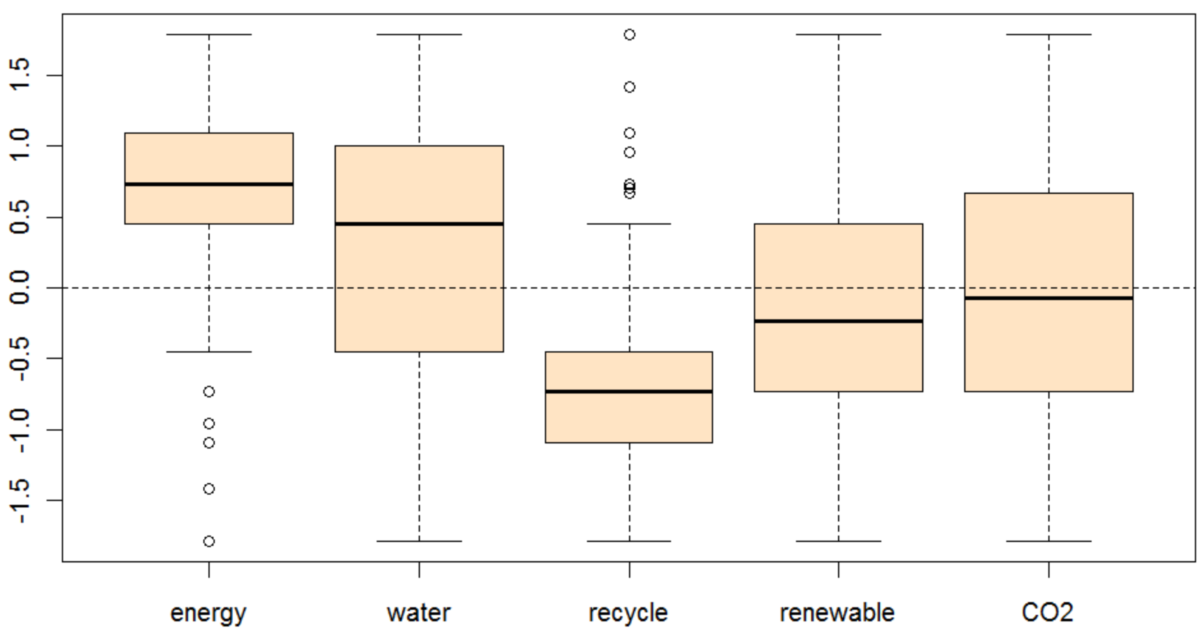


**Figure 36. Normalized distribution for environmental attribute importance ratings.**

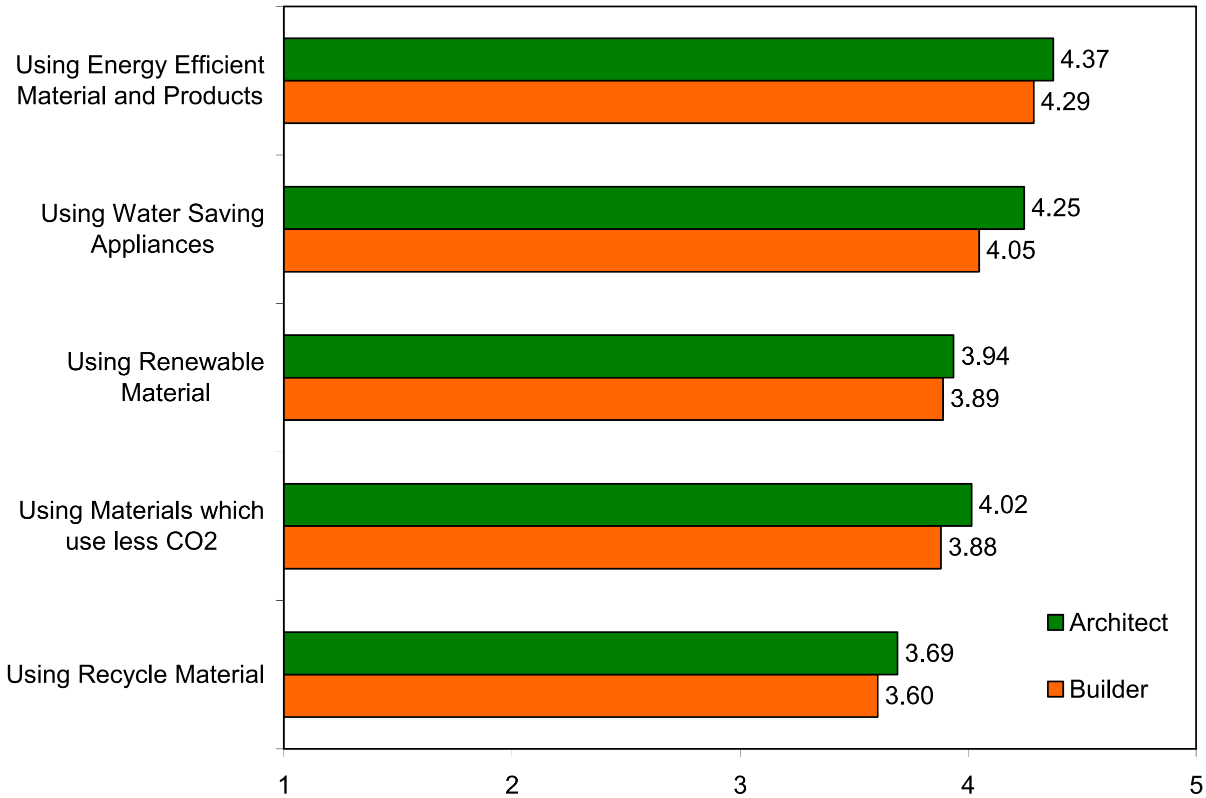


**Figure 37. Importance ratings of environmental attributes for builders and architects.**

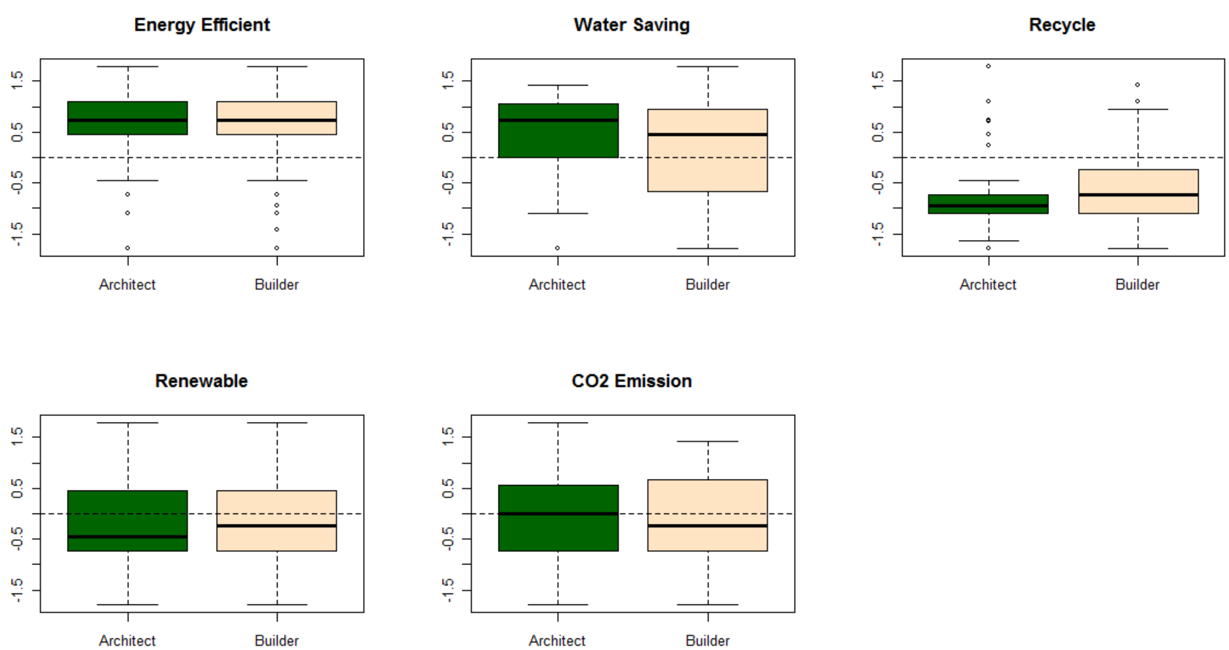


**Figure 38. Normalized distributions of importance ratings of environmental attributes for builders and architects.**

## Results of the China Green Building Survey

The new green building program in China, the Chinese Evaluation Standard for Green Building (Three Star System), has the potential to increase the demand for wooden building materials (both primary and secondary manufactured wood products) used in residential construction. The extent of its impact on demand is influenced by the degree to which it is accepted and utilized by developers, builders and architects. However, the Chinese residential construction market differs significantly from that in Japan, both in terms of size, as well as the type of structural materials used and the type of residential buildings that are constructed. While single family houses are the dominant housing type built in Japan, they represent only a tiny fraction of the market in China, which is dominated by medium-rise apartment buildings and condominiums. In addition, although wood frame construction both post and beam and 2x4) is the major construction method in Japan, there is little wood frame construction in the residential sector in China. The vast majority of residential building construction in China utilizes reinforced concrete and steel.

The number of annual housing starts in China is a matter of great speculation and uncertainty, partially because China's statistics on housing starts are not based on the number of houses built but rather on the total floor area built. As a result, there is substantial confusion and inaccuracy when trying to translate the Chinese housing data into housing starts. According to the National Bureau of Statistics of China (NBSC), the total investment for the development of "villa" and high-end apartment buildings in 2009 was US$30 billion, which was around 8% of the total investment for all real estate development including residential and commercial buildings. If we use $1,000 per square meter as the unit construction price for villas and high-end apartment buildings ( a realistic estimate), the total floor area for this high end segment of the housing market would be approximately 30.4 million $m^2$. Assuming that the average floor area of each unit is 200 $m^2$, the total number of single family and high end apartment starts would be 152,000 in 2009, which would be approximately 3.6% of the total floor area built in 2009. There is no data about single family starts available on NBSC's website. However, based on the estimates of industry managers, single family housing starts represent about 10%-15% of the 152,000 high end housing units (villas and apartments) built in 2009. On this basis, we can estimate that the number of detached single family homes built in China in 2009 was approximately 15,200 ~ 22,800, with less than 2,000 of these being wood frame construction (Fang 2010).

### Survey Methodology

To better understand how design professionals and developers perceive and use the green building program in China, a series of surveys were conducted at several seminars, following the same methodology as that used in Japan. The following discussion is based on an analysis of the 150 surveys collected from Chinese construction professionals during the Evergreen Building Products Association's US-China Build trade mission in Hangzhou, Wuhan and Qingdao, China in September 2009. The survey was designed to collect information to help us better understand developer's and design professional's attitudes towards the Chinese green building program and their perceptions of the environmental performance of wooden building materials relative to non-wood materials.

**Table 11. Classification of survey respondents by occupation.**

| Business type | Number | Percentage |
|---|---|---|
| Landscape Design | 2 | 1.3% |
| Media | 4 | 2.7% |
| Distributor-timber | 4 | 2.7% |
| Distributor-building materials | 6 | 4.0% |
| Industry Association | 10 | 6.7% |
| Design Institute | 16 | 10.7% |
| Developer | 26 | 17.3% |
| Other | 30 | 20.0% |
| Interior Design-Architect | 52 | 34.7% |
| **Total** | **150** | **100%** |

## Results

Among the survey respondents, 34.7% were architects/design professionals, 17.3% were developers, 10.7% were affiliated with a design institute and 20% were classified as "other", Table 11. Survey respondents were asked to indicate their awareness and use of the Chinese green building program. Interestingly, almost 95% of respondents had heard of the program although 52.1 % reported that, while they had heard about the program, they had never used it, Figure 39. An additional 31.4% reported that they planned to use the program although they had not used it to this point and finally, 10.7% of respondents indicated that they have used the green building program.

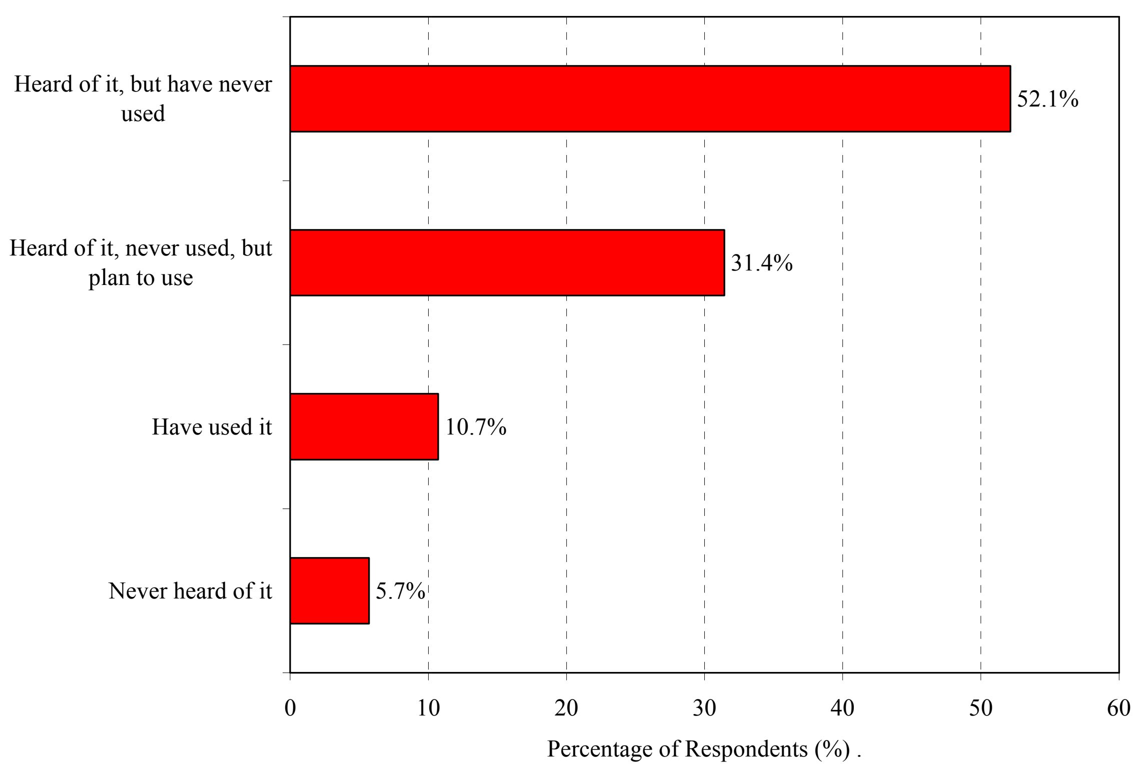


**Figure 39. Survey respondent's awareness and use of the Chinese green building program.**

Survey respondents were then asked to rate the effectiveness of the green building program in China. Approximately half of the survey respondents indicated that they were not sure how effective the program has been while an additional 40.3% felt that the green building program had been somewhat effective, Figure 40. Only 6.7% and 1.5% of respondents felt that the green building program has been somewhat ineffective or ineffective, respectively.

Respondents were also asked to rate the relative importance of four environmental attributes in influencing their design or building process: 1) using energy efficient materials and products, 2) using renewable materials, 3) using water saving appliances and fixtures and 4) using recycled materials, Figure 41. All of the environmental attributes received importance ratings that were significantly higher than the neutral rating of 3, suggesting that they are all perceived as playing an important role in the design or building process. The survey results show that using energy efficient materials and products was significantly more important than the other environmental attributes. The second most important environmental attributes was "using renewable materials" followed by "using water saving appliances and fixtures. Finally, the environmental attribute with the lowest importance rating was "using recycled material", although its rating was still significantly higher than the neutral rating of 3.

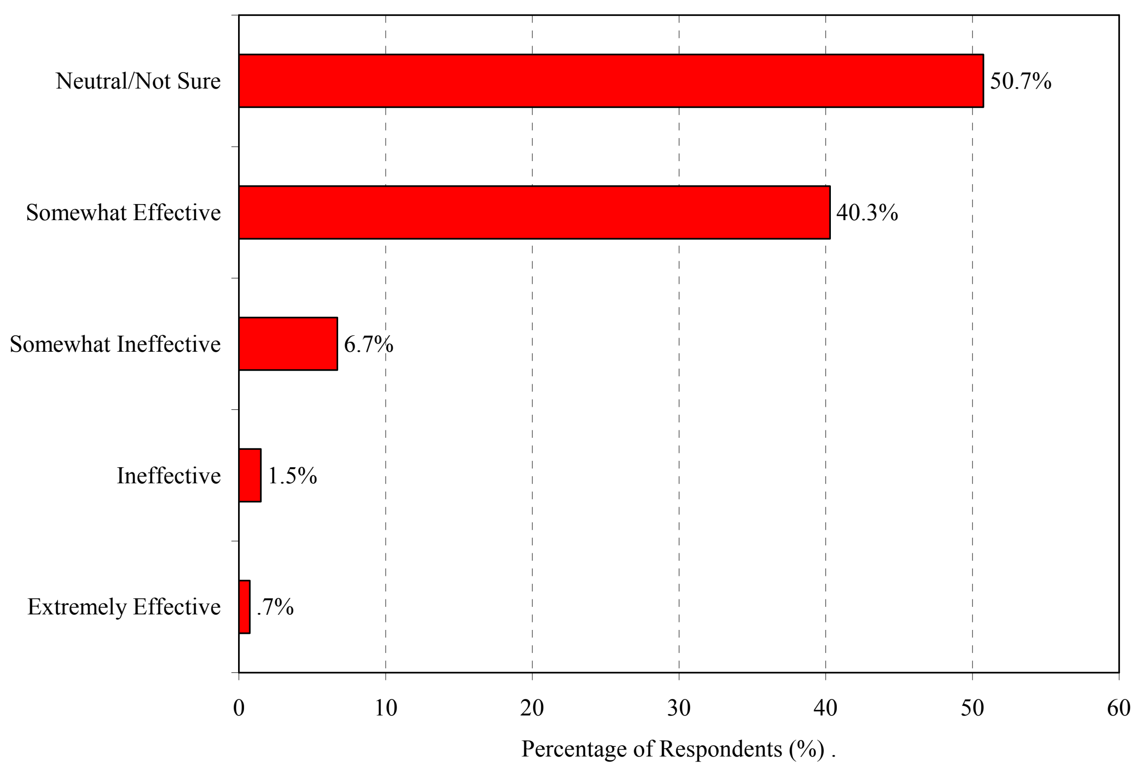


**Figure 40. Survey respondent's perceptions of the effectiveness of the green building program in China.**

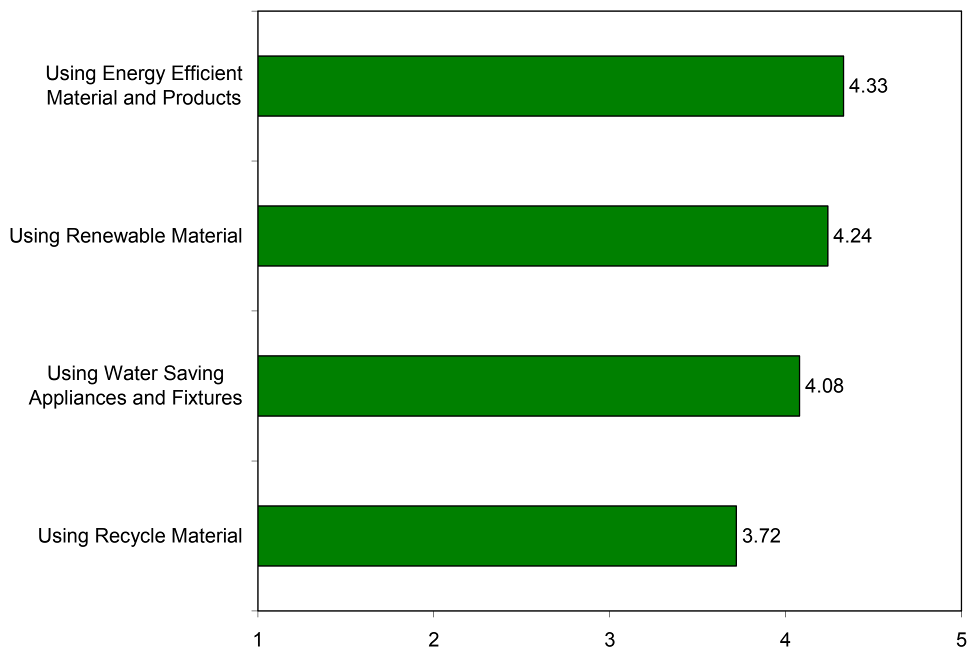


**Figure 41. Summary of the average importance ratings for the four environmental attributes in China.**

### Perceived relative environmental performance of structural building materials

This project was also designed to gain a better understanding of building professionals perceptions of the relative environmental performance of the three major structural building materials used in China (wood, steel and concrete) along a number of performance measures. The performance measures included in the Chinese survey differed slightly from those used in the survey conducted in Japan and included: energy use during manufacturing of the raw materials, pollution generated during manufacturing of the raw materials, energy efficiency of the completed house, and the overall sustainability of the three structural building materials. In this section of the research, Chinese building professionals were asked to provide their assessment of the relative environmental performance of wood versus steel versus concrete as a structural building material in residential construction.

Chinese construction professionals overwhelming perceived that the relative energy use required to manufacture the three structural building materials was lowest for wood while concrete was widely perceived to require medium energy use and steel required the greatest amount of energy input, Figure 42. Almost two-thirds (64.5%) of respondents felt that energy use was lowest for wood compared to just 17.2% for concrete and 12.1% for steel. In contrast, almost two-thirds felt that the energy input required to manufacture a product was highest for steel (63.3%) while just over 20% felt that it was highest for concrete and wood.

Respondent’s again overwhelming perceived wood to be the most environmentally friendly structural building material with respect to the amount of pollution generated during the manufacturing process, Figure 43. Over eighty percent (82.1%) perceived that that the amount of pollution generated during the manufacturing process was lowest for wood. In contrast, almost half of the respondents felt that concrete production generated the greatest amount of pollution while a similar proportion of respondents perceived that steel generated the greatest amount of pollution. Combining medium and high pollution responses for both concrete and steel suggests that Chinese builders perceive that these two structural building materials are similar in terms of the amount of pollution generated during the manufacturing process.

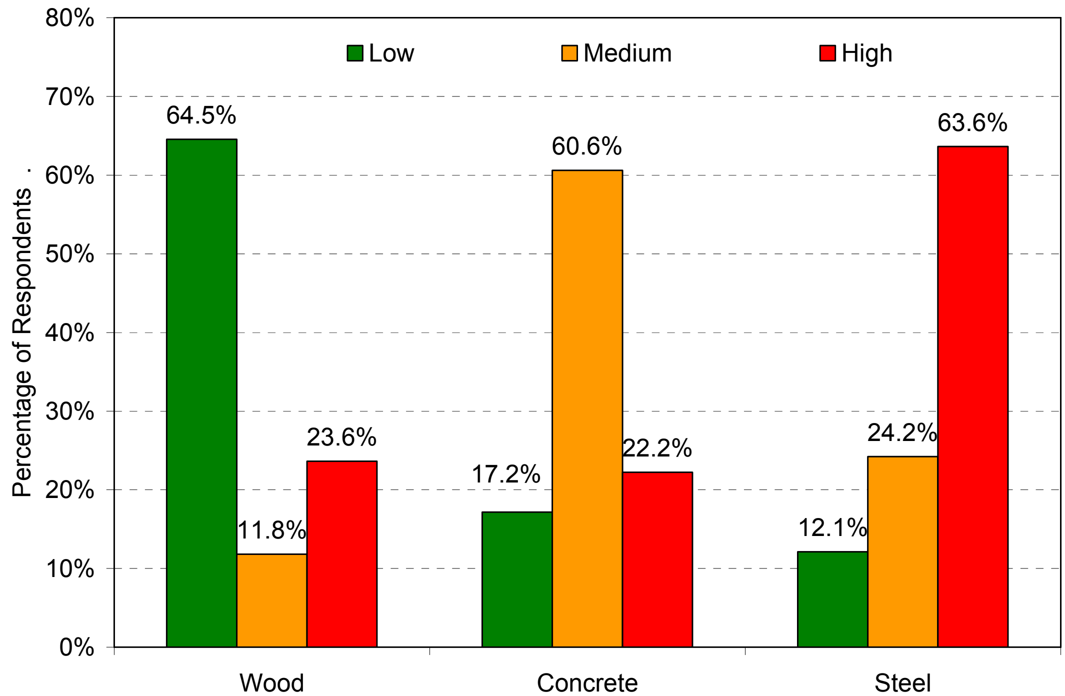


**Figure 42. Respondent's perceptions of the relative energy use during the manufacturing process for wood, steel and concrete.**

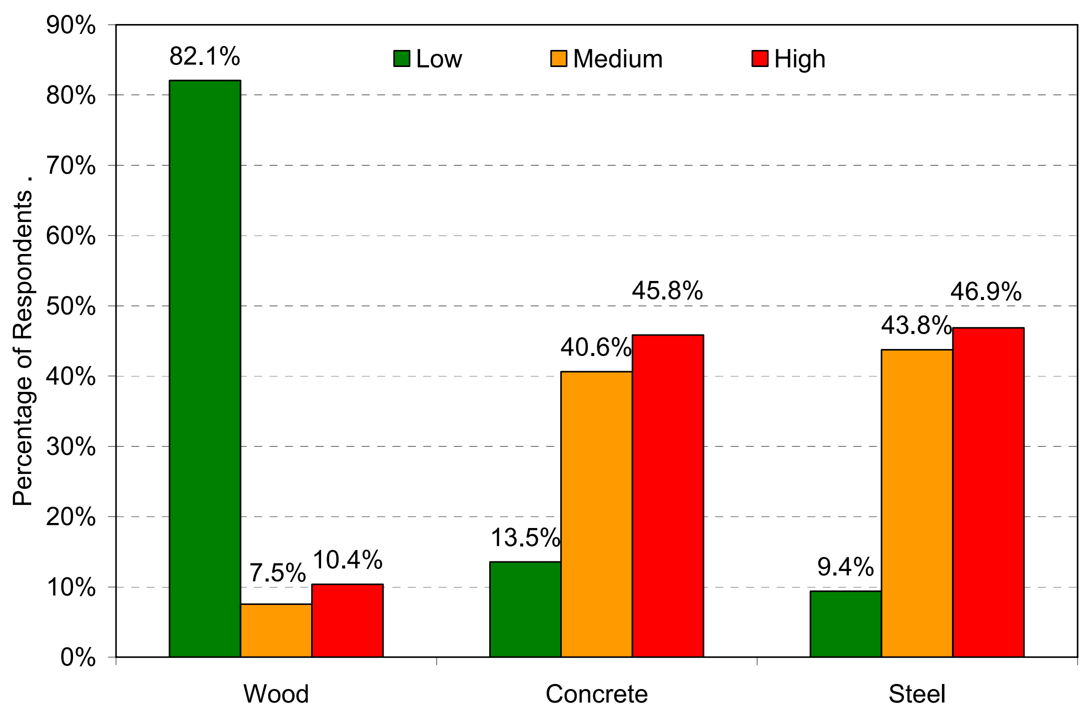


**Figure 43. Respondent's perceptions of the level of pollution generated during the manufacturing process for wood, steel and concrete.**

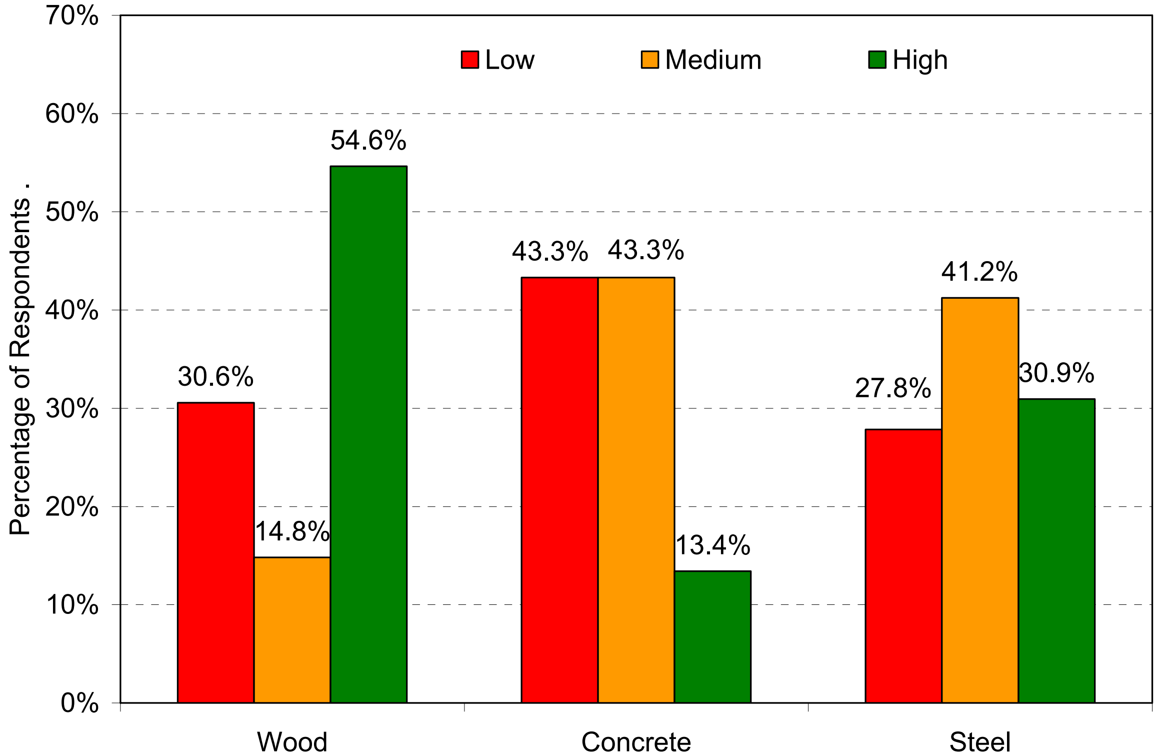


**Figure 44. Respondent's perceptions of the relative resource sustainability for wood, steel and concrete.**

Survey respondents perceived that wood used as a structural building material had the highest level of resource sustainability relative to steel and concrete, Figure 44. Over half of Chinese builders (54.6%) viewed wood as the most sustainable building material compared to 30.9% for steel and just 13.4% for concrete. However, respondent's perspective on the sustainability of wood was somewhat divided with 54.6% reporting it as being highest whereas a sizable 30.6% felt that the resource sustainability of wood was the lowest of the three materials. In fact, the low resource sustainability score for wood was substantial, although Figure 44 clearly shows that wood is viewed in a more favorable light than either concrete or steel, with steel was perceived as being somewhat more sustainable than concrete.

Finally, Chinese respondents reported that wood buildings provided the highest level of energy efficiency relative to either steel buildings or concrete buildings, Figure 45. Over half of the respondents (53.3%) felt that wood homes were the most energy efficient compared to 32.6% for steel homes and 19.8% for concrete homes. The proportion of respondents who reported low energy efficiency was fairly similar for each of the structural building materials, ranging from 21.9% for concrete to 31.6% for steel.

Chinese builders feel that the most important material attribute is using energy efficient products and materials, followed closely by using renewable materials. Both of these observations suggest that opportunities exist to market energy efficient US wood building materials in China (e.g., wood windows and cellulose insulation). The survey results obtained regarding the relative environmental performance of wood, concrete and steel clearly shows that Chinese construction professionals recognize that wood and wooden structures provide superior environmental performance across a variety of environmental measures spanning the life cycle of a material. This trend is similar to the trend observed in Japan.

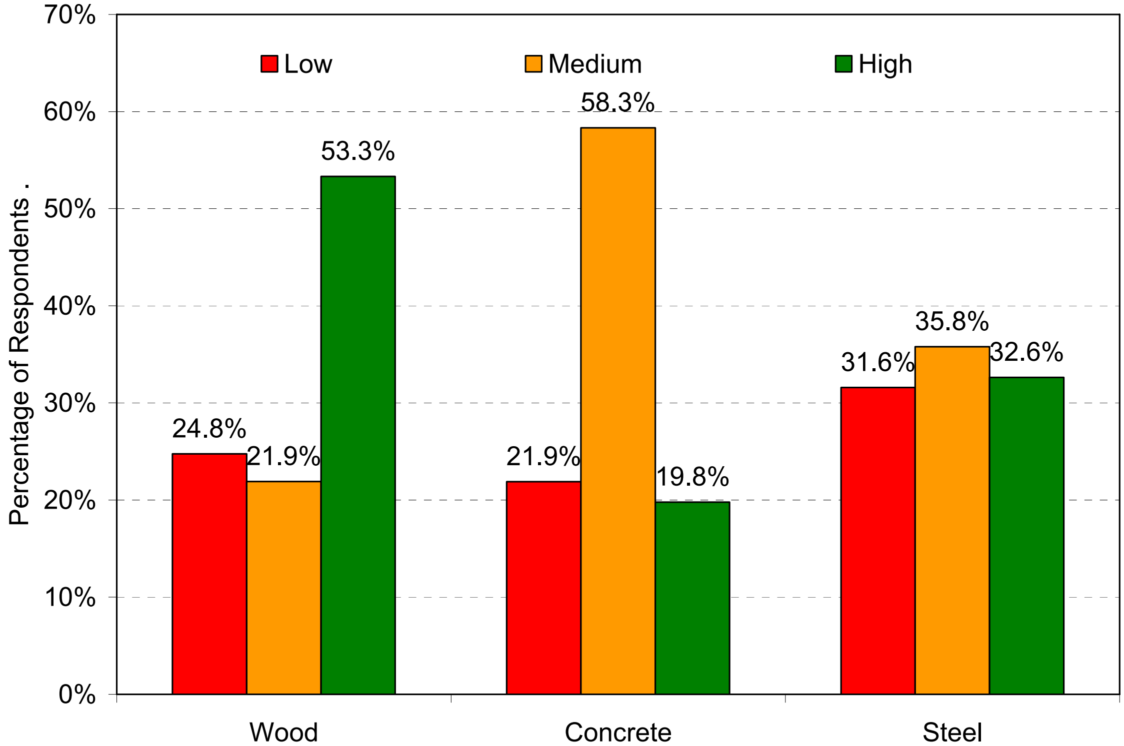


**Figure 45. Respondent's perceptions of the relative energy efficiency of a home built using wood, steel and concrete as the structural building material.**

## Comparison of the Results of the Green Building Surveys from China and Japan

### Level of Awareness of Green Building Programs in China and Japan

In this section of the report we compare the responses obtained in Japan to those obtained in China across a number of common survey questions, beginning with respondent's awareness of green building programs. A significantly higher proportion of respondents in China (94.3%) reported that they had heard about the green building program compared to Japan where only 35.2% of survey respondents were aware of the CASBEE-House green building program, Figure 46. However, the greater level of awareness in China did not translate into a higher level of usage. In this regard, the survey results show that the proportion of respondents who report having built a home using the green building program in their country was almost the same in both countries; 10.7% in China versus 10.0% in Japan.

### *Perceived effectiveness of green building programs in China and Japan*

Building professionals in China and Japan were asked to assess the effectiveness of their green building programs based on their observation and experience. By a margin of almost 4 to 1, a substantially larger proportion of building professionals in China perceived their green building program as being effective compared to their Japanese counterparts, Figure 47. In contrast, less than 10% of Chinese building professionals felt the green building program in China was ineffective compared to almost 35% in Japan. Almost half of all respondents in both countries had a neutral perception towards the effectiveness of the green building programs in their countries.

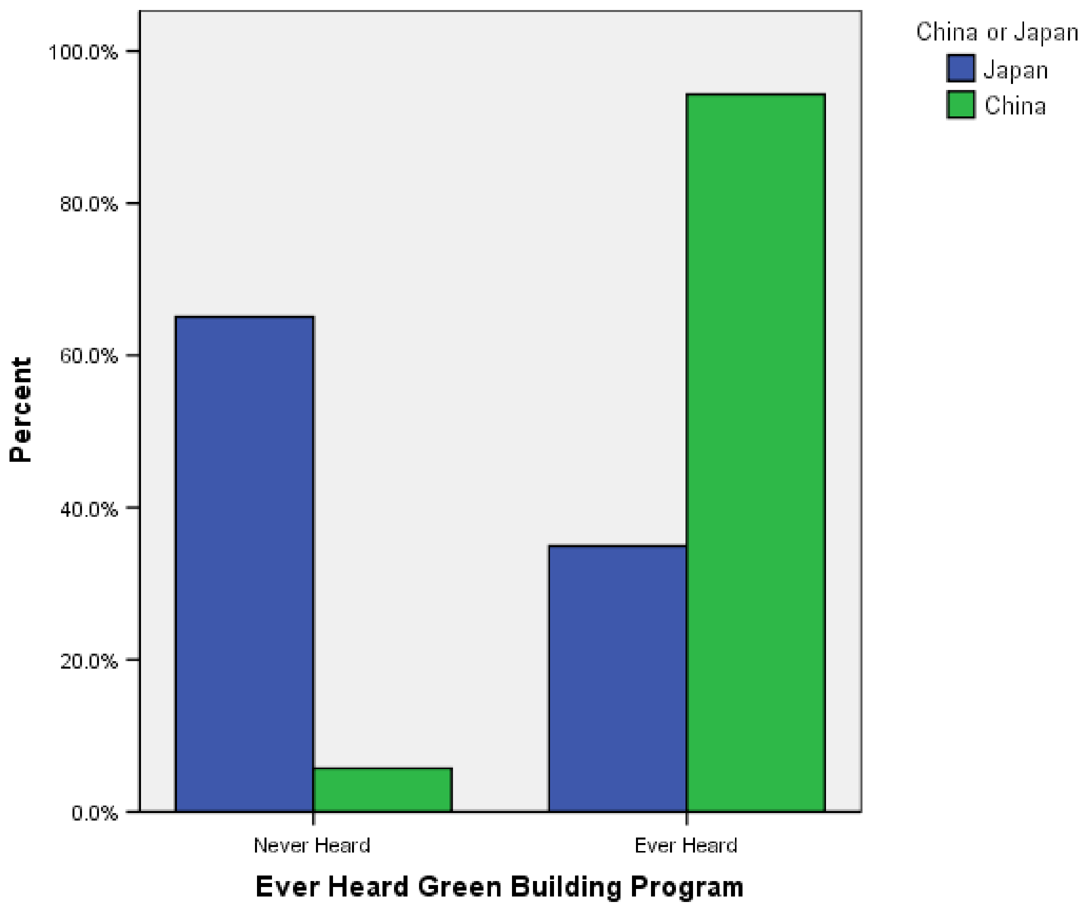


**Figure 46. Comparative levels of awareness of green building programs in China and Japan.**

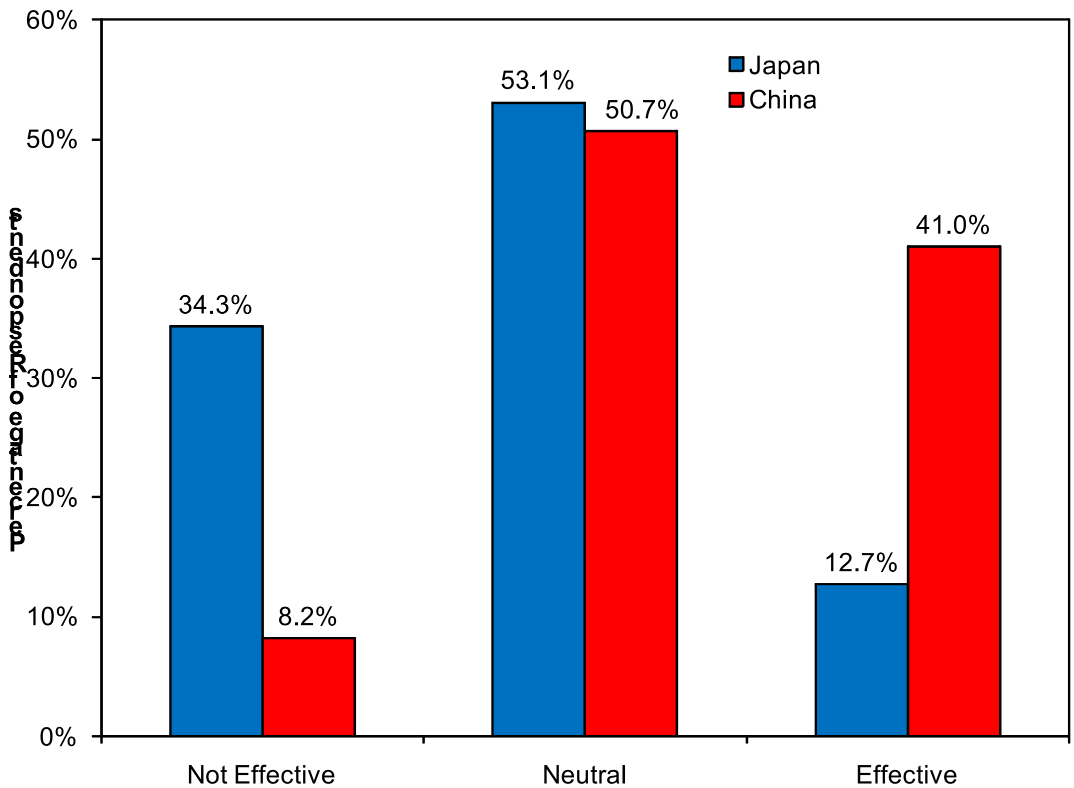


**Figure 47. Perceived effectiveness of green building programs in Japan and China.**

***Perceived importance of environmental attributes in China and Japan***

Survey respondents in both countries were asked to rate a set of environmental attributes in terms of how important they were in influencing their material purchasing decision. The environmental attributes included in both surveys were: 1) using energy efficient materials and products, 2) using renewable raw materials, 3) using water saving appliances and fixtures and 4) using recycled materials, Figure 48. A comparison of the results obtained from both surveys shows that the importance ratings are extremely similar. The singular exception is for the attribute "using renewable raw materials" which the Chinese respondents rated substantially higher than their Japanese counterparts. Overall, it would seem that builders and design professionals in both countries view the environmental attributes in a similar way. This suggests that a similar marketing message emphasizing common environmental attributes might be effective in promoting wood building materials in both countries.

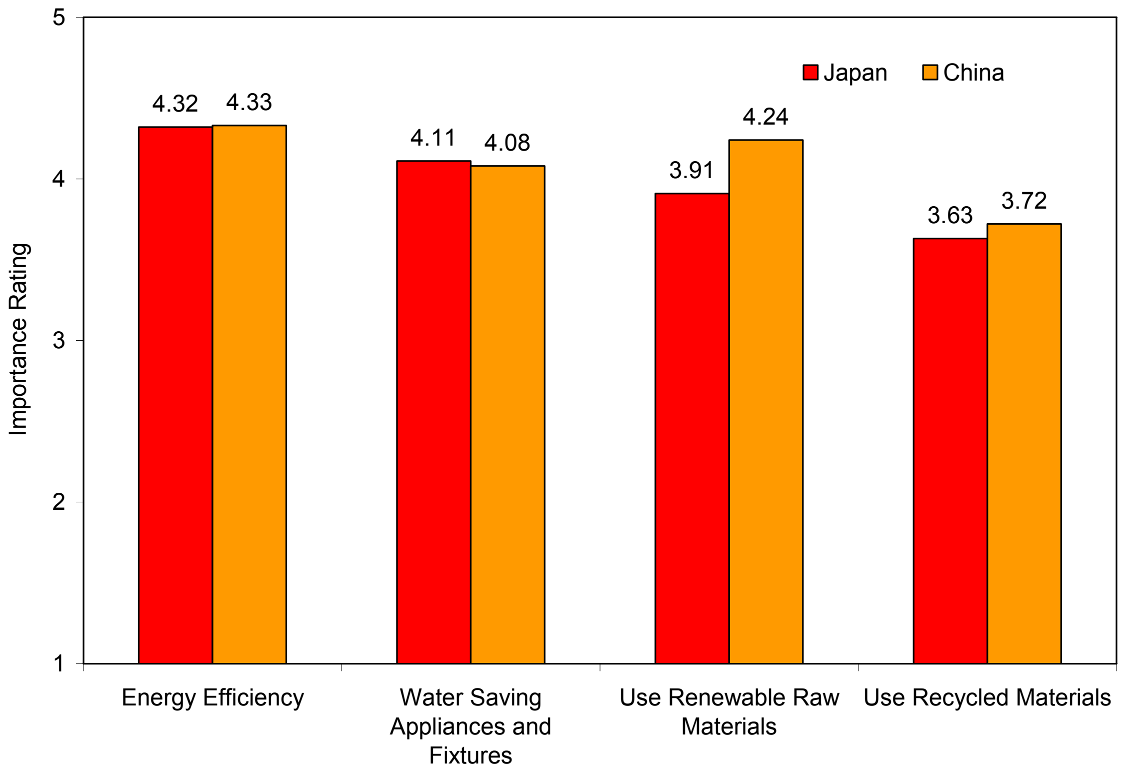


**Figure 48. Comparative average importance ratings for the four environmental attributes in China and Japan.**

***Perceived relative environmental performance of structural building materials in China and Japan***

Respondent's perceptions of the environmental performance of structural materials (lumber, concrete and steel) across a set of environmental attributes were compared between building professionals in China and Japan, Figure 49. The results of the analysis of the normalized data are presented in Appendix C which used a two-way ANOVA to look for significant differences between materials (material effects) and significant differences between materials based on the nationality of the survey respondent (interaction effect between country and material).

The results of the statistical analysis showed that the perceived energy use for the three material choices was significantly different ($p<.001$), while at the same time the interaction between country and material displayed a significant difference as well ($p=.009$) (Figure C1 and Table C1, Appendix C). The responses of Chinese and Japanese building professionals regarding energy use during the manufacturing process were fairly similar for both wood and steel whereas their perception of the energy use in manufacturing concrete were significantly different, with Japanese respondents rating it much higher than their Chinese counterparts. Respondents in both countries perceived that wood used significantly less energy during the manufacturing process than either steel or concrete. They also perceived that steel used the greatest amount of energy. In contrast, a significantly higher proportion of Chinese respondents perceived concrete as using a medium amount of energy during manufacturing than did Japanese respondents who were significantly more likely to rate energy use during the manufacture of concrete as being high relative to their Chinese counterparts.

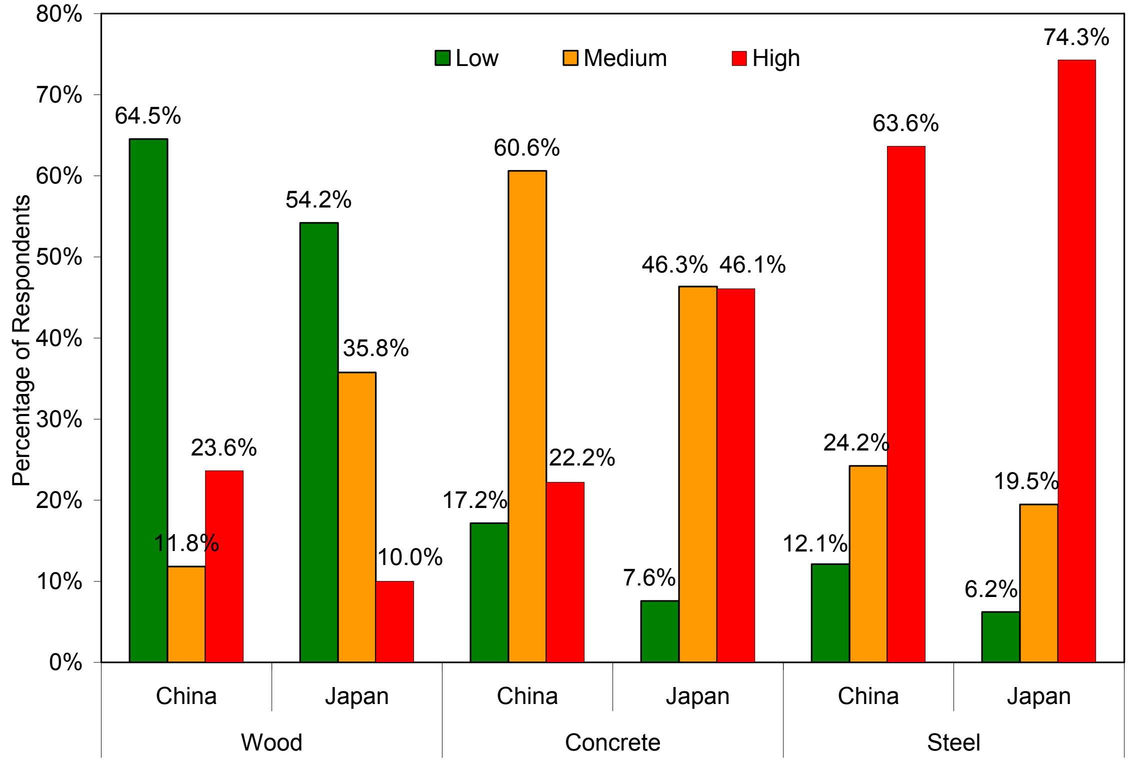


**Figure 49. Respondent's perceptions of the relative energy use during the manufacturing process f or wood, steel and concrete (Japan versus China).**

The results of the statistical analysis also show that the perceived level of pollution associated with the three material choices was significantly different ($p<.001$), while at the same time the interaction between country and material was not significantly different ($p=.310$) (Figure C2 and Table C2, Appendix C). Both Chinese and Japanese respondents perceived that the manufacturing process for wood generated a significantly lower amount of pollution than either steel or concrete, Figure 50. Both sets of respondents also rated steel as generating the highest amount of pollution during manufacturing although they differed with respect to the amount of pollution generated from concrete manufacturing; with the Chinese being equally split between a high amount of pollution and a medium amount whereas the majority of the Japanese respondents rated it as medium.

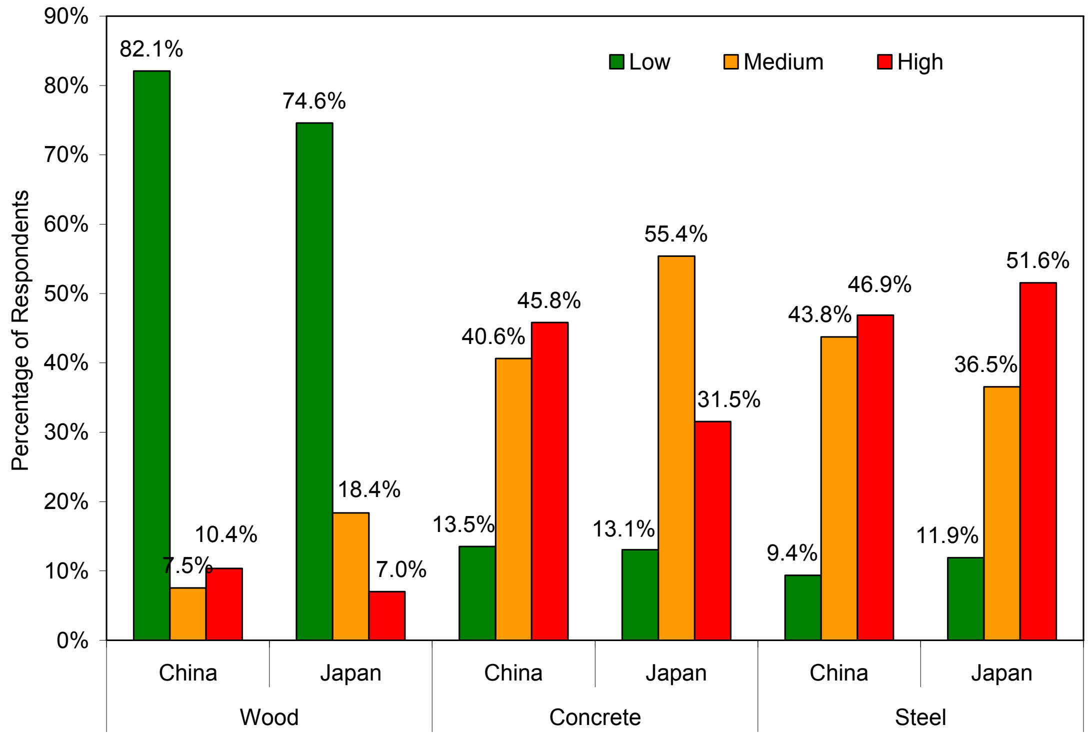


**Figure 50. Respondent's perceptions of the level of pollution generated during the manufacturing process for wood, steel and concrete (China versus Japan).**

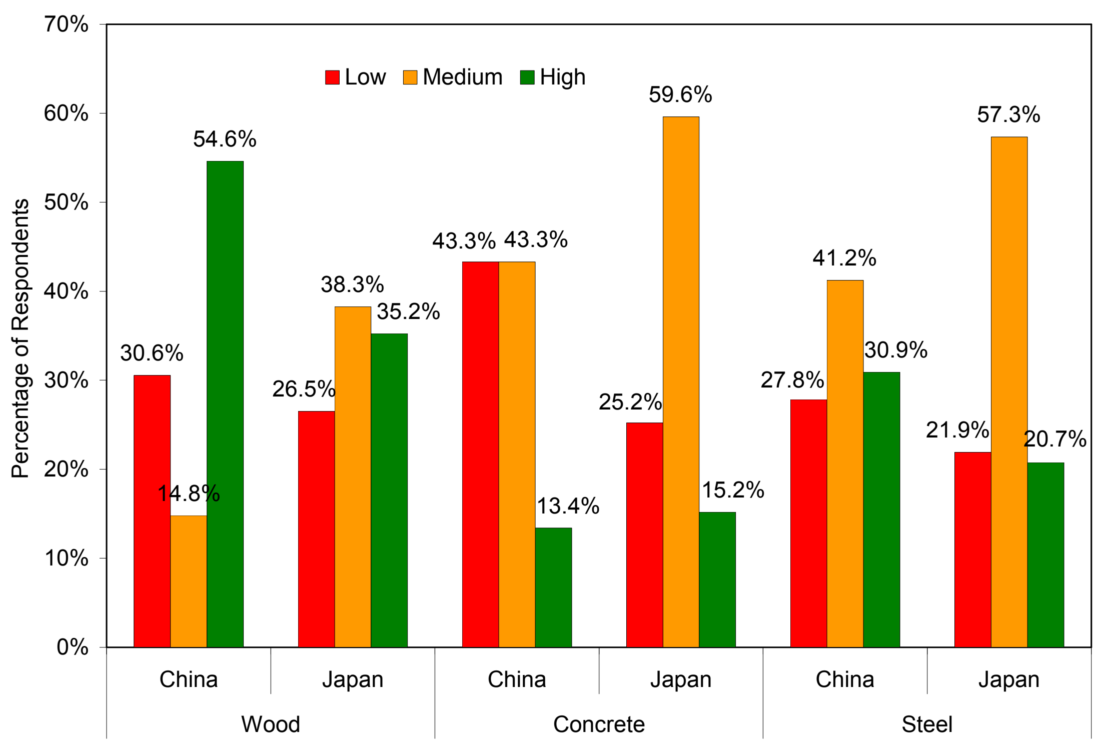


**Figure 51. Respondent's perceptions of the relative resource sustainability for wood, steel and concrete (Japan versus China).**

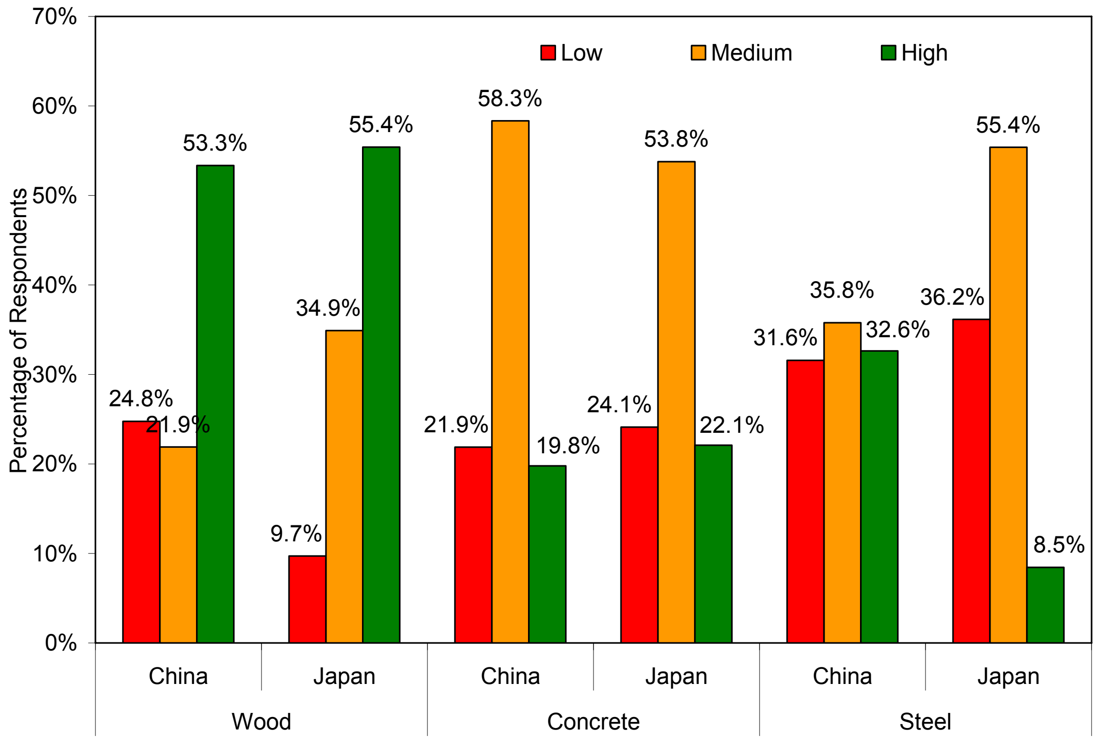


**Figure 52. Respondent's perceptions of the relative energy efficiency of a home built using wood, steel and concrete as the structural building material.**

Respondents perceptions of the relative resource sustainability of the three materials was a bit more ambiguous, although the majority of respondents from both countries perceived that wood had the highest level of sustainability and concrete had the lowest level of sustainability, Figure 51, Figure C3 and Table C3). The statistical analysis showed that there were significant differences between the ratings provided for the different materials (p=.000). Similarly, there was also a significant difference in the interaction between country and material responses (p=.018).

Finally, a majority of respondents from both countries rated the energy efficiency of wooden building as being high and clearly superior to either steel or concrete, Figure 52. Steel structures were rated as having the worst energy efficiency by both sets of respondents, with concrete building being rated as medium in terms of energy efficiency The statistical analysis showed that there were significant differences between the ratings provided for the different materials (p=.000). Similarly, there was also a significant difference in the interaction between country and material responses (p=.000).

Overall, these results show that wood is clearly perceived by respondents from both China and Japan as providing superior environmental performance relative to steel and concrete across all four of the environmental attributes being evaluated. In general, concrete was rated as providing medium environmental performance across all of the environmental attributes (with the exception of resource sustainability) while steel was rated as providing the worst environmental performance on all environmental measures with the exception of resource sustainability where it was rated as being medium.

## Summary Observations

### Japan

While the CASBEE-House green building program is a voluntary program that was jointly developed by the residential construction industry and the Ministry of Land, Infrastructure and Transportation (MLIT), residential builders appear hesitant to adopt the program. Our initial interviews with managers of several large home builders indicated that the major home building companies have been involved, to varying degrees, in the development of the CASBEE-House program (including Mitsui Home, Sekisui House, Sumitomo Forestry, Misawa Home, and Daiwa Home, among others). Based on our discussions with industry experts, it appears likely that small local home builders and medium-sized regional home builders are less likely to use the CASBEE-House green building program to any large degree because the primary customers for these homebuilders are older homeowners who are typically replacing an existing older home. The consensus opinion among smaller homebuilders is that these customers are more conservative, less environmentally aware and less likely to be willing to pay a higher price to build a new house that is certified under the CASBEE-House program. In contrast, powerbuilders (medium-sized regional or national home building companies that specialize in spec home developments that are often sold to younger, first time home buyers) appear to be more willing to use the program as a way to differentiate their homes from those of their competitors and also because their primary customers tend to be younger, more educated homebuyers who are more concerned about the environment.

However, the ultimate success and widespread acceptance of the CASBEE-House program will rest upon its acceptance by the large national home builders. While our discussions with managers at several large home building companies suggest that most large home building companies are not using the program to any large degree, the managers we talked with noted that if one large company were to widely adopt the program, other large homebuilders would likely follow suit to prevent their competitor from gaining a marketing advantage with potential home buyers. There was also some concern among industry managers that the CASBEE-House program might transition from a voluntary program to a mandatory program, similar to the process that has occurred with the Green Procurement program, although this is probably more of a concern in the commercial construction sector than the residential construction sector.

Our research results support this observation. A surprisingly high proportion of survey respondents (69.7%) reported that they had never heard of the CASBEE-House green building program. Of those respondents who indicated that they had heard about CASBEE-House, the largest proportion reported that they had never used CASBEE-House. Overall, only 8.7% of the respondents indicated that they had built a home using the CASBEE-House green building program. Large builders were significantly more likely to have heard of CASBEE-House and to have built homes using the green building program than were either medium-sized builders or small komuten. In contrast to CASBEE-House, building professionals were much more likely to have heard about, and to have used, the 200 Year House program. Over 90% of builders had heard about the 200 Year House program while over 45% had built houses using the program. In contrast, just 70% of architects were aware of the 200 Year House program while only 14% reported using the program. By the end of 2010, less than 1,000 houses had been built and certified under the CASBEE-House program whereas the total number of houses built under the 200 Year House program exceeded 106,000.

The results of the survey data clearly show that Japanese building professionals perceive wood to be the most environmentally friendly structural building material across all six of the environmental performance measure included in the survey. In contrast, steel is perceived as being the least environmentally friendly structural building materials across most of the environmental performance measures, with the exception of “sustainability of the resource”. Energy efficiency of the house was found to be the most importance environmental attribute and it was rated as being significantly more important than all of the other attributes. Using water saving appliances and fixtures was found to be the second most important environmental attribute

### China

Set against the backdrop of the global economic downturn, the Chinese housing sector has shown some encouraging signs of recovery. China's construction industry has grown at an average annual rate of 20% since 1990. Housing markets in major cities have recently started to pick up again thanks in part to government's 4 trillion yuan stimulus package. According to China Data Center, investment in new construction between January and May 2009 has reached over 2.5 trillion yuan, jumped by 43% compared to the same period of last year.

Since 2006, the Chinese government has been working to promote its "4-savings and 1-environmental" housing ideology, which stands for: energy-saving, land-saving, water-saving, raw material-saving and less pollution. The Center for Housing Industrialization, founded in 1998, has initiated several key national projects and drafted guidelines for improving productivity of construction and promoting the "healthy" and "environmental" properties of residential buildings in urban areas. According to the 11th five-year plan initiated by the Ministry of Housing and Urban-Rural Development of (previously, the Ministry of Construction), by the end of 2017 the level of industrialization of the Chinese housing sector will reach 30% from its current 7-8%, and the average service life of residences is expected to double from the current 50 years to 100 years. China has also started to develop 10 demonstration housing projects, 10 experimental cities, and 10 model construction enterprises. Currently, most construction in China is concrete and brick, with the market for wood frame buildings growing very slowly due in large part to the government's strict restrictions on land use in urban areas as well as the fact that wood frame building codes were only recently approved. After the Sichuan earthquake that occurred in May 2009, the Canadian Wood Association increased its participation in reconstruction projects in the region and donated $8 million to help build wood frame houses and low-rise commercial buildings (schools and health clinics) for local residents. This has been reported widely in China and in turn helped wood frame construction gain broader market recognition.

The new green building program in China, the Chinese Evaluation Standard for Green Building (Three Star System), has the potential to increase the demand for wooden building materials (both primary and secondary wood products) used in residential and low-rise commercial construction. The extent of its impact on demand is influenced by the degree to which it is accepted and utilized by developers, builders and architects. However, the Chinese residential construction market differs significantly from that in Japan, both in terms of size, as well as the type of structural materials used and the type of residential buildings that are constructed. While single family houses are the major housing type in Japan, they represent only a small portion of the market in China, which is dominated by medium-rise apartments and condominiums. In addition, although wood frame construction is the major construction method in Japan, there is little wood frame construction in the residential sector in China. It is estimated that the number of detached single family homes built in China in 2009 was approximately 15,200 ~ 22,800, with less than 2,000 of these being wood frame construction (Fang 2010).

Wood frame construction has increasingly been accepted into the Chinese market. In February 2009, the Shanghai government approved a B.C.-designed roofing system as part of a plan to renovate 10,000 city apartment buildings in the lead-up to the World Expo 2010 in Shanghai. As China moves to develop more and more "green" houses, experts predict that timber construction will continue to gain recognition within the government and the construction sectors in China, thereby opening up new opportunities for green building materials and engineered wood products. Also, the projects by the Canadian Wood Association in Sichuan suggest that wood frame construction for houses and low-rise commercial buildings could be successful in Chinese rural areas where land use has been less regulated by local governments.

In China, almost 95% of the survey respondents reported that they have heard of the green building program, a third planned to use the program and just over ten percent have already used the green building program.  Chinese builder's report that the most important influential material attribute is the energy efficiency of products and materials, followed closely by whether or not a material uses renewable materials.  Both of these observations suggest that opportunities exist to market energy efficient wood products (e.g., wood windows and cellulose insulation) for use in multi-story, multi-family condominium and apartment buildings.  The survey results obtained for the relative environmental performance of wood, concrete and steel clearly show that Chinese construction professionals perceive that wood and wooden structures provide superior environmental performance across a variety of environmental measures spanning the life cycle of a material.  This trend is similar to the trend observed in Japan and suggests that expanding the use of wood frame buildings in both countries is possible.

## Strategic Recommendations

A number of programs (including green building programs) focused on improving the environmental performance and energy efficiency of homes have been adopted in China and Japan. The results of this research clearly shows that builders, architects and design professionals in both countries perceive wood to be the most environmentally friendly building material, and that homes built from wood are more energy efficient than homes built from steel or concrete. These trends set the stage for promoting the superior environmental performance of value-added wood building materials such as wood windows and doors. For example, the Eco-Point program in Japan provides a unique opportunity to promote energy efficient US wooden windows in the new home construction sector as well as the growing repair and remodel sector in Japan.

The results of this research project clearly show that there are a variety of market opportunities for expanding US exports of value-added wooden building materials into Japan and China. Perhaps the best market opportunity exists for increasing exports of wood windows given the emphasis in both countries on increasing the energy efficiency of new and existing buildings. This will be easier to accomplish in China than in Japan where restrictive fire codes require the certification of wood windows used in fire and quasi-fire zones. In addition, the green building programs in Japan and China provide a good market opportunity to expand exports of cellulosic insulation, structural insulated panels and value-added wood products used in interior applications that are made from certified wood (e.g., wood cabinets and flooring). Finally, good opportunities exist to increase exports of certified structural wood products such as glue-laminated beams, metric sized lumber, dimension lumber and treated lumber using the new generation of less toxic wood preservatives.

In order to increase the exposure of US value-added wood products among building professionals in Japan and China, US exporters should strongly consider participating in the wide variety of trade shows and trade missions by joining industry associations that are active in international markets and have a proven track record of providing access to qualified buyers in these countries. For example, the Evergreen Building Products Association offers trade missions to Japan and China several times a year. Similarly, the State of Washington Department of Commerce sponsors trade missions for wood products manufacturers to Japan. Finally, industry associations such as the Softwood Export Council and the American Hardwood Export Council provide opportunities for US companies to rent booth space within the US Wood Pavilion at trade shows in Japan and China (such as the Japan Home and Building Show in Tokyo, the KH Housing Fair in Seoul and Interzum China in Shanghai) in addition to trade shows in Europe, Mexico and the Middle East. All of these trade associations provide tremendous logistical support for US exporters and manufacturers of wood building materials, allowing them to focus their energy on meeting potential customers for their products (a list of upcoming trade shows and missions is available at: http://www.softwood.org/calendar.htm.

Efforts to reinforce favorable perceptions of wooden building materials and continue to educate Japanese and Chinese building professionals regarding the superior environmental performance of wood as a building material relative to steel and wood are important in strengthening the position of US wood building materials. Companies should consistently reinforce this message in their promotional literature, sales presentations, and meetings with potential customers. In addition, it would be useful to translate a brief summary of the results of the CORRIM Life Cycle Assessment research on the environmental performance of wood homes relative to steel and concrete homes. This type of brief presentation can underscore the superior environmental performance of wood building materials including their effectiveness in improving the energy efficiency of the houses and low-rise commercial structures. It can also demonstrate the benefits of incorporating cradle to grave life cycle assessment methodologies that take into account the entire range of environmental impacts of building materials into green building programs.

US and Canadian industry associations have been working together to gain approval of a 2x4 wood frame construction building code in China. Now that this has been achieved, US industry groups need to continue working with their Canadian counterparts to develop the market for multi-story, multi family wood frame apartment buildings and low-rise public buildings (e.g., health clinics and schools) in China, particularly areas outside the larger cities. This effort should focus on emphasizing the superior performance of wood frame buildings (relative to steel and concrete) in terms of earthquake resistance and energy efficiency. At the same time, they should continue their efforts to expand the use of wood in hybrid construction, in interior applications in condominium and apartment buildings, and in exterior landscaping projects.

US industry groups should also be working with the US government in Japan to address the issue of prefectural subsidies aimed at increasing the use of domestic wood in residential homes, the de-facto certification of domestic forests as being sustainably managed and prescriptive targets for increasing the market share of domestic wood within the post and beam housing sector. All of these measures act as non-tariff barriers that undermine the increased use of imported wood and are myopic in their focus. Rather than fighting for a larger share of a static market, Japanese and US wood manufacturers should be working together to increase the market for wood products by promoting the environmental benefits and improved structural performance that can be achieved by substituting wood for steel and concrete in residential construction and low-rise commercial structures; thereby increasing the overall size of the market for wood products to the benefit of wood manufacturers in both countries.

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## Appendix A.

## Survey of Green Building Programs in Japan

**1. Are you a builder? Yes ______ No ______**

**2. Have you heard about the CASBEE-House green building program? Yes ______ No ______**

**3. Has your company built any houses using the CASBEE-House program? Yes ______ No _______**

***If yes, how many homes did your company build in 2008 using the CASBEE-House program? _______homes***

**4. Please indicate your opinion of the CASBEE-House and Choki Yuro Jutaku programs (L=Low, M=Medium, H=High).**

| | CASBEE-House | Choki Yuro Jutaku |
|---|---|---|
| Current effectiveness/usefulness of each building program so far? | | |
| Current level of customer interest about each building program? | | |
| Future outlook for each building program in five years. | | |

**5. Does your company offer a long life home under the Choki Yuro Jutaku program.** ❑ Yes ❑ No

**-- If yes, how many homes did your company sell under the Choki Yuro Jutaku in 2008**. ________ houses

**6. How important are each of the following attributes in influencing your choice of building materials. (1=Not Important, 3= Neutral, 5=Extremely Important). (Please circle one).**

| | **Not at all important** | **Not Important** | **Neutral** | **Important** | **Extremely Important** |
|---|---|---|---|---|---|
| Energy efficiency | 1 | 2 | 3 | 4 | 5 |
| Water saving (appliances and fixtures) | 1 | 2 | 3 | 4 | 5 |
| Use recycled materials | 1 | 2 | 3 | 4 | 5 |
| Renewable raw materials | 1 | 2 | 3 | 4 | 5 |
| $CO_2$ emission during manufacture and transportation | 1 | 2 | 3 | 4 | 5 |

**7. How would you evaluate the following environmental attributes for each of the listed building materials. (1=Low, 2=Average, 3=High)?**

| | **Wood** | **Concrete** | **Steel** |
|---|---|---|---|
| Energy use during the manufacturing process | H M L | H M L | H M L |
| Pollution generated during the manufacturing process | H M L | H M L | H M L |
| CO2 emission during manufacture and transportation | H M L | H M L | H M L |
| Sustainability/renewability of resource | H M L | H M L | H M L |
| Energy efficiency of the completed house | H M L | H M L | H M L |
| Overall environmental friendliness of the building material | H M L | H M L | H M L |

**8. Approximately how many housing units did your company build in 2008? ______________** houses

**9. How many years has your company been building homes? ____________________**years

**10. What percentage of the housing units you built in 2008 were:**

| | |
|---|---|
| Multi-Family | % |
| Single Family | % |
| **Total** | **100%** |

| | |
|---|---|
| Wooden | % |
| Non-Wooden | % |
| **Total** | **100%** |

**11. What percentage of the wood houses you built in 2008 were:**

| | |
|---|---|
| Post & Beam | % |
| 2x4 | % |
| Prefab | % |
| **Total** | **100%** |

| | |
|---|---|
| Custom | % |
| Built for sale | % |
| **Total** | **100%** |

**12. In what region or prefecture of Japan does your company build homes?**

______________________________________

## Appendix B.

## Survey of Green Building Material Use in China

**1. Please specify your main business type** (Developer, Design Institute/Architect, Trade Association, Building Materials Trader, Wood Trader, Government, Landscape Designer, Media, Other)

__________________________________________________

**2. Please indicate your knowledge and using experience with the green building standards/guideline in China: (Please Check one of the following options)**

❑ I <u>have not heard</u> about China's green building standards

❑ I <u>have heard</u> about China's green building standards but never used this in any project
(if possible, please specify the name of the standard/guideline:________________________________________)

❑ I <u>have heard</u> about China's green building standards, I never used them but plan to use this in the next 2 years.

❑ I <u>have used</u> China's green building standards in one/some of my projects
(if possible, please specify the name of the standard/guideline:________________________________________)

**3. Please rate the effectiveness of China's green building standards so far**

| 1<br>Not at all Effective | 2<br>Somewhat Ineffective | 3<br>Neutral | 4<br>Somewhat Effective | 5<br>Extremely Effective |
|---|---|---|---|---|
| | | | | |

**4. How important are each of the following attributes in influencing your material selection (1=not important, 5=extremely important)**

| | 1<br>Not at all important | 2<br>Not Important | 3<br>Neutral | 4<br>Important | 5<br>Extremely Important |
|---|---|---|---|---|---|
| Energy efficiency | | | | | |
| Renewable raw materials | | | | | |
| Water saving (appliances and fixtures) | | | | | |
| Use recycled materials | | | | | |

**5. How would you evaluate environmental attributes of the following materials as a building material? (1= Low, 2= Average, 3=High)?**

| Environmental Attribute | Materials | | |
|---|---|---|---|
| | Wood | Concrete | Steel |
| Energy use during manufacturing | | | |
| Sustainability of resource | | | |
| Pollution generated during manufacturing | | | |
| Energy efficiency of completed building | | | |

**6. Do you have any comments regarding green building development in China?**

## Appendix C.

## Results of the statistical comparison of responses from China and Japan.

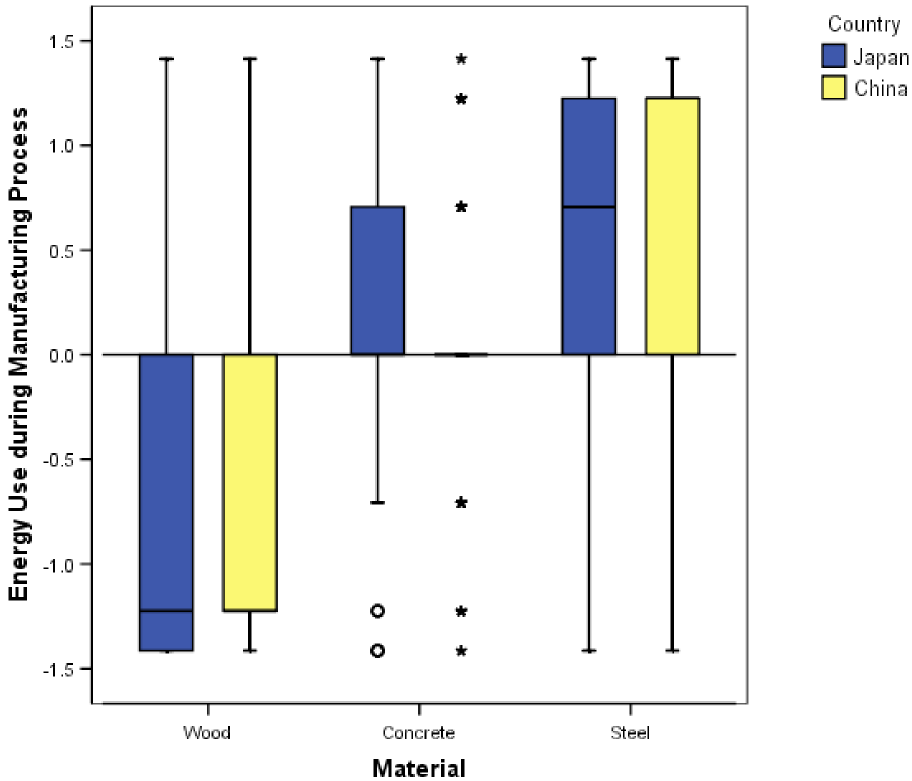


**Figure C1. Normalized distributions of importance ratings for energy use during the manufacturing process (Japan versus China).**

**Table C1. Two-way ANOVA with the Dependent Variable being Energy Use during the Manufacturing Process.**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 325.818(a) | 5 | 65.164 | 116.293 | .000 |
| Intercept | .000 | 1 | .000 | .000 | 1.000 |
| Material | 239.627 | 2 | 119.813 | 213.824 | .000 |
| Country | .000 | 1 | .000 | .000 | 1.000 |
| Material * Country | 5.327 | 2 | 2.663 | 4.753 | .009 |
| Error | 568.182 | 1014 | .560 | | |
| Total | 894.000 | 1020 | | | |
| Corrected Total | 894.000 | 1019 | | | |

a R Squared = .364 (Adjusted R Squared = .361)

** Since environmental attributes are standardized over materials, the mean of total is zero; therefore, country and intercept should not have any variability at all.

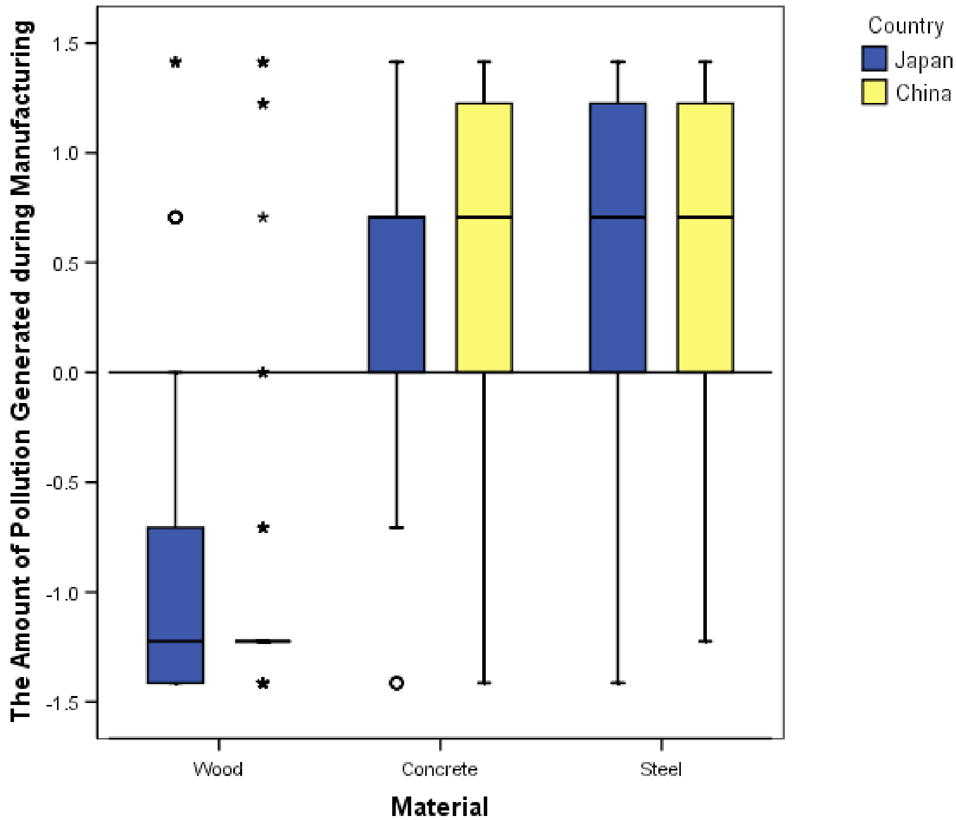


**Figure C2. Normalized distributions of importance ratings for pollution generated during the manufacturing process (Japan versus China).**

**Table C2. Two-way ANOVA with the Dependent Variable being Pollution Generated during the Manufacturing Process.**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 402.484(a) | 5 | 80.497 | 172.151 | .000 |
| Intercept | .000 | 1 | .000 | .000 | 1.000 |
| Material | 336.940 | 2 | 168.470 | 360.291 | .000 |
| Country | .000 | 1 | .000 | .000 | 1.000 |
| Material * Country | 1.096 | 2 | .548 | 1.172 | .310 |
| Error | 461.516 | 987 | .468 | | |
| Total | 864.000 | 993 | | | |
| Corrected Total | 864.000 | 992 | | | |

a R Squared = .466 (Adjusted R Squared = .463)

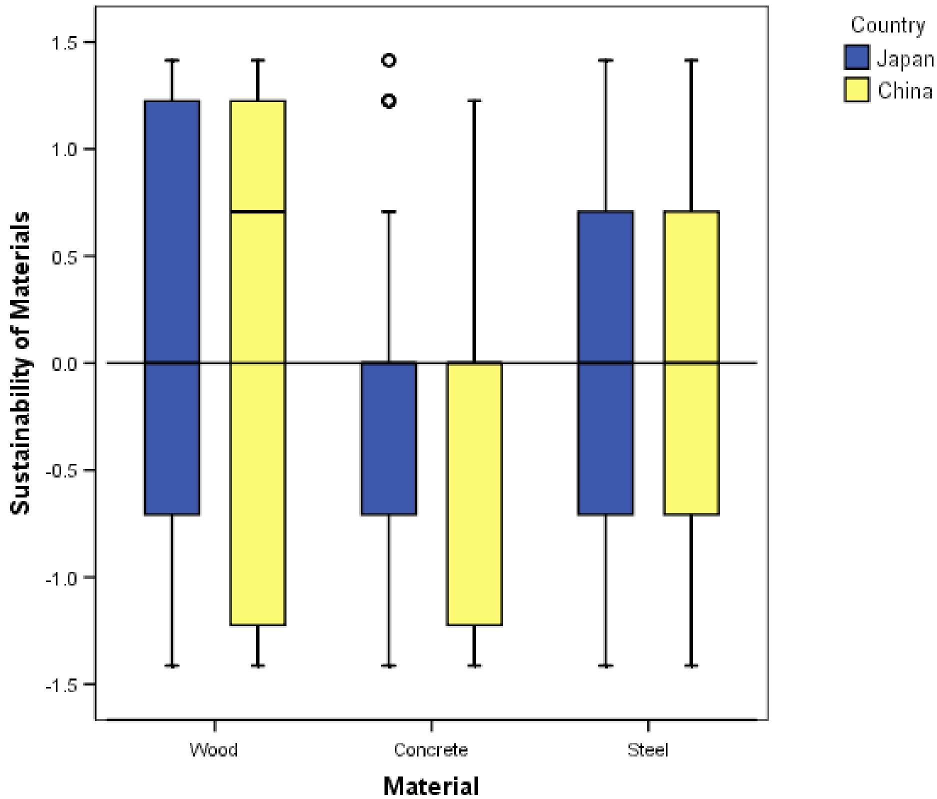


**Figure C3. Normalized distributions of importance ratings for sustainability of materials (Japan versus China).**

**Table C3. Two-way ANOVA with the Dependent Variable being Sustainability of Raw Materials.**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 31.565(a) | 5 | 6.313 | 8.726 | .000 |
| Intercept | .000 | 1 | .000 | .000 | 1.000 |
| Material | 31.473 | 2 | 15.736 | 21.750 | .000 |
| Country | .000 | 1 | .000 | .000 | 1.000 |
| Material * Country | 5.842 | 2 | 2.921 | 4.037 | .018 |
| Error | 718.435 | 993 | .723 | | |
| Total | 750.000 | 999 | | | |
| Corrected Total | 750.000 | 998 | | | |

a R Squared = .042 (Adjusted R Squared = .037)

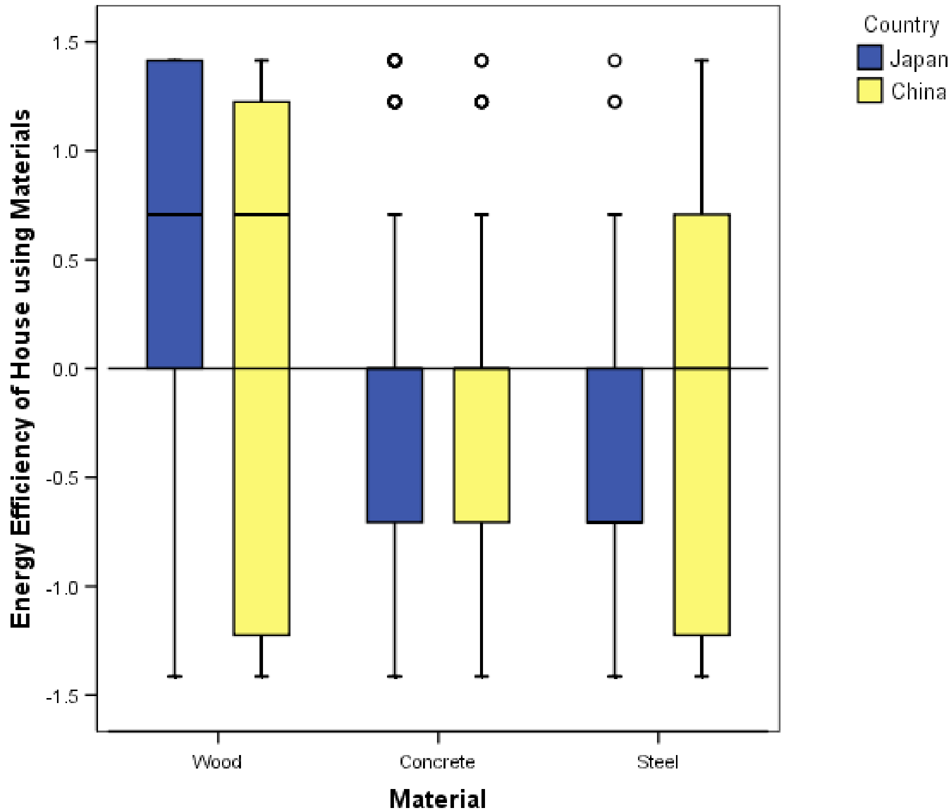


**Figure C4. Normalized distributions of importance ratings for energy efficiency of the completed house (Japan versus China).**

**Table C4. Two-way ANOVA with the Dependent Variable being Energy Efficiency of Houses built from Different Materials.**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 132.070(a) | 5 | 26.414 | 39.324 | .000 |
| Intercept | .000 | 1 | .000 | .000 | 1.000 |
| Material | 66.642 | 2 | 33.321 | 49.607 | .000 |
| Country | .000 | 1 | .000 | .000 | 1.000 |
| Material * Country | 16.055 | 2 | 8.028 | 11.951 | .000 |
| Error | 656.930 | 978 | .672 | | |
| Total | 789.000 | 984 | | | |
| Corrected Total | 789.000 | 983 | | | |

a R Squared = .167 (Adjusted R Squared = .163)