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Evaluating the Certification System of Green Building Materials in China

June 2017

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Acronyms and Abbreviations

AAMA	American Architectural Manufacture's Association
ANSI	American National Standards Institute
AQSIQ	Administration of Quality Supervision, Inspection, and Quarantine of China
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing Material
CABR	China Academy of Building Research
CMA	China Metrology Association
CNAS	China National Accreditation Service for Conformity Assessment
CNCA	Certification and Accreditation Administration of China
CQC	China Quality Certification Center
CQM	China Quality Mark Certification Group
CTC	China Building Material Test & Certification Group Co., Ltd
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GJC	Guojian Lianxin Certification Center
ICAS	Shanghai Ingeer Certification Assessment Co., Ltd
IEC	International Electrotechnical Commission
ISO	International Standardization Organization
LAP	Laboratory Accreditation Program (NFRC's)
LEED	Leadership in Energy and Environmental Design
MIIT	Ministry of Industry and Information Technology of China
MOHURD	Ministry of Housing and Urban-Rural Development of China
NFRC	U.S. National Fenestration Resource Council (U.S.)
SAC	Standardization Administration of China
SHGC	Solar Heat Gain Coefficient

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Executive Summary

Certification of green building materials is a proven and effective way to incorporate, at large scale, products that are energy efficient, have minimal ill effect on indoor air quality, and/or have other green attributes into buildings. Recently, the General Office of the State Council of China, in order to increase the supply of high-quality green products into the buildings market, issued guidance on developing a uniform system for green product standards and certification by 2020.[1] This guidance is one of many high-level government plans to employ certification as a fundamental tool to increase the market share of green building materials.

This report investigates the certification and testing system in China and the United States relevant to green building materials in order to identify areas for improvement and provide recommendations for China's certification system. Moreover, to provide a basis for comparison, we examine certification systems in both the United States and China to identify shared features among programs that are indicative of a successful program. We conducted analysis by exploring program websites, reviewing the literature, and carrying out structured interviews.

Areas for improvement in the Chinese system include the following:

- Greater uniformity in testing protocols for a specific product property,
- More consistency in testing results among laboratories,
- Better streamline certifications for individual product categories,
- Greater alignment among performance standards,
- Inclusion of product categories that presently have no coverage from an existing certification program,
- Stronger promotion strategy to get more products certified, including linkages to policies and incentives, demonstration projects, and energy-efficiency monitoring, and
- Greater number of products certified by instituting a continuous or graded certification scheme.

Greater uniformity in testing protocols for a specific product property: Subjecting a class of products to the same testing process enables better comparisons to be made among products on a specific and often important metric. Best practices are where a large share of a class of products follows a common testing standard for a product property. Each certification system, for example, could use the same national testing standard for a product property. Disparate testing protocols, on the other hand, can lead to a fragmented system that makes it difficult to objectively compare products and inhibits a common platform from being used to make transformative changes in the product market.

More consistency in testing results among laboratories: Ensuring that the material will perform as advertised is the cornerstone of a certification program. Robust testing, therefore, is a critical component of the certification's market value. Although there are programs monitoring results across laboratories, certain certification programs lack requirements to ensure testing results are consistent. Best practices are where laboratories performing the same testing protocol must participate in periodic inter-laboratory comparisons, blind competence evaluations, and other validation measures, which are carried out by an

oversight body. Furthermore, clear independence is needed among certification groups, laboratories, developers, and manufacturers to avoid potential conflicts of interest.

Better streamline certifications for individual product categories: Under the voluntary certification system, accredited institutions can issue their own certifications, which can often lead to product categories covered by multiple certifications that cover the same or related properties. Moreover, each certification institution can have their own rules and standards to achieve their respective certification.

Many of these certifications have come about to recognize products across a range of prices and properties, but the diversity of unconnected certifications for a single product category may confuse the consumer and increase the burden to manufacturers who seek to distinguish their products. It would be helpful to streamline certifications on the same or similar properties for a number of reasons, including lowering the burden to manufacturers, increasing consumer awareness, and creating better market acceptance of green-certified products.

Greater alignment among performance standards: Similar to the issue with the number of certifications, there is an overlapping of performance standards such that multiple standards exist in the same category of products, without due justification such as difference in climate. Performance standards can be created by the national government, industry associations, and certification groups if they deem existing standards to be inadequate for their program. It is beneficial to market uptake if performance standards can be aligned with each other and/or other policies, such as building energy codes. Alignment of standards can accelerate the uptake of green products by overcoming market barriers, reducing costs, and speeding time-to-market.

Include product categories that presently have no coverage from an existing certification program: Certification labels provide consumers an aspect other than price for which to compare products, thereby helping the consumer to make more informed choices and understand the different categories of performance. Some products important to the green building sector, such as energy-efficient window coatings, however, have no relevant certification program. A gap in coverage of product classes can lead to lower overall market penetration of certified-products and limit the potential of the building to be more fully composed of high-performing products.

Stronger promotion strategy to get more products certified, including linkages to policies and incentives, demonstration projects, and energy-efficiency monitoring: A number of strategies could be implemented to better promote the use of green-certified building materials. As is the case in many countries, demonstration projects, energy-efficient monitoring, and government policy can be very effective in creating conditions favorable for market uptake. Such policies include project bidding, tax incentives, subsidies, inclusion on government procurement lists, and linkage to building energy codes. Other strategies include training and media campaign to help raise awareness and create consumer demand. Similarly, removing obstacles such as district heating pricing according to energy consumption as opposed to floor space can be effective.

Greater number of products certified by instituting a continuous or grade certification scheme: High participation rates extend the benefits of certification industry wide. A continuous or graded certification program can better encourage the participation of all products in the class to get certification, such as those from smaller manufacturers that may not be able to produce products in the top echelon of performance or those that compete in the marketplace on other attributes (e.g., aesthetics), while still

giving commensurate recognition to the best products. Alternatively, for products that far exceed the standards set by certification, manufacturers could supplement the certification by making self-declarations, which would be supported by testing from accredited laboratories.

概要

绿色建材认证可以有效推进绿色建材的大规模应用，全面提升绿色建筑品质。国务院办公厅 2016 年印发《关于建立统一的绿色产品标准、认证、标识体系的意见》，要求按照统一目录、统一标准、统一评价、统一标识的方针，构建统一的绿色产品标准、认证、标识体系。在此基础上，本报告通过研究中美绿色建材认证、测试体系，总结成功的绿色建材认证项目的共有特性，并以此作为比较评价基础，为绿色建材认证体系提出进一步完善的建议。具体建议如下：

- 提高不同认证体系间测试方法的统一性；
- 增强不同检测实验室测试结果的一致性；
- 简化同类产品的认证；
- 进一步协调针对同类产品同一性能的不同标准；
- 涵盖更多产品类别；
- 通过示范工程建设、能效监测、激励措施及加强与其他政策的联系促进推广认证产品的应用；
- 增加获得标识产品的数量。

提高不同认证体系间测试方法的统一性 针对同类产品的某一特定性能，市面上往往存在不同的认证体系。统一这些认证体系的测试过程可提高测试结果间的可比性。针对同类别产品同一性能的不同认证、标识，应使用同一种测试方法。现有的针对同类产品同性能的不同标识采用不同的测试评价体系，阻碍了同类产品间的客观比较、统一评价平台的建立以及绿色建材认证市场的改革。

增强不同检测实验室间测试结果的一致性 确保产品性能符合宣传效果是任何一个认证系统的基础。因此，测试结果的可靠性是一个认证标识市场价值的决定性因素。虽然现有认证项目涵盖对检测实验室的监管，但一些认证项目缺少对实验室间测试结果一致性的要求。同一认证体系下的检测实验室应当每年参与实验室间比对、能力评估及其他校验活动，以确保测试结果的一致性。此外，认证机构、检测实验室、及制造商应保持各自的独立性，从而避免利益冲突。

简化同类产品的认证 自愿性产品认证系统允许具备相应资质的认证机构颁发自己的认证标识，因此市面上存在针对同类产品类似性能的多种认证标识（如针对同类产品的节能认证和低碳认证）。与此同时，认证机构可以制订其标识的测试标准和认证规则。在建材产品类目下，共有 30 家国家认监委认可的认证机构、470 套认证规则、120 种认证标识，以及 900 部测试标准。

虽然这些认证体系可针对不同价格区间的产品进行类似性能的认证，但这种分散的认证体系不仅会增加消费者辨识和选择产品的难度，也给试图提高自身产品辨识度的厂商增加了负担。简化同类产品类似性能的认证种类可减轻厂商的负担，提高消费者对产品的认知，并增加绿色节能建材产品的市场认可度。

进一步协调针对同类产品同一性能的不同标准 同样，针对同类产品的同一性能存在不同的产品标准。政府，行业，协会，及认证机构皆可根据需要制订相应的标准。促进不同标准间、标准与认证项目间的协调，有助于增加绿色建材产品的市场占有率。协调不同标准可促进绿色建材产品克服市场壁垒，降低成本，促进市场投放，从而加快市场占领。

涵盖更多产品类别 一些建材产品并没有相应的绿色建材产品标准，比如节能窗户涂层等。不全面的产品种类覆盖会阻碍绿色建材产品的市场渗入，从而阻碍其在节能建筑中的全面应用。

通过示范工程建设、能效监测开展、激励措施及加强与其他政策的联系促进推广认证产品的应用
推广绿色建材认证产品的应用可借助一系列策略。国际经验表明，示范工程建设及其能效监测开展、政府的政策导向可为绿色建材认证产品的推广创造有利环境，增加其市场份额。这些政策包括：工程招投标，税收优惠，政府补贴，纳入政府采购目录并予以优先考虑，将供暖费与采暖能耗挂钩，及与建筑节能标准相关联等。此外，还可以通过培训及媒体宣传等其他策略提高社会节能意识，从而刺激对绿色节能建材认证产品的消费需求。

增加获得标识产品的数量 标识使得消费者可以从价格以外的因素比较不同的商品，了解产品多方面的性能，从而做出更明智的消费选择。更多企业参与到认证系统中可提升整个绿色建材行业的品质。连续或分级的标识体系能够更好地将各种产品纳入其中（比如性能达不到顶尖水平的小制造商的产品，或依靠出色外观等其他特性提高竞争力的产品），同时又能确保该体系下性能最优的产品获得相称的认可。或者对性能远高于认证标准的产品，生产商可以通过提供具有相应资质实验室的检测报告，自行申报产品性能，对认证进行补充。

1.0 Introduction

Buildings play an essential role in modern life, but the degree to which they impact people and the environment is highly dependent on how they are constructed, managed, renovated, and demolished. Green building practices that conserve resources and limit waste production are critical to providing a healthy and comfortable living and working environment.

Incorporating green building practices is important in all building markets, but in particular in China. China's construction market is the largest in the world. In 2015, China built more than 4.2 billion square meters of new building floor space, which is greater than the entire building stock of Canada and seven times the floor space additions in the United States of the same year [2, 3]. China's construction market is expected to continue to see strong growth and add around 30 billion square meters of building floor space between 2015 and 2050, based on a recent estimate from the International Energy Agency.[4] Much of the future building stock is being built in the next several decades,[5] and is expected to last beyond the lifetime of its occupants. Building final energy consumption (including traditional biomass) accounts for about 28% of total final energy consumption in China, and if embodied energy is accounted for, the share would be much greater [6, 7]. In addition, due to rapid income growth, urbanization, and changes in lifestyle, building energy consumption in China is expected to increase rapidly in the future. Many materials integral to the building's structure, such as insulation and concrete, are difficult to modify without deep retrofits and, as such, have long lifetimes, highlighting the urgency to incorporate materials that are green.

Buildings account for around 30% of the greenhouse gas emissions in China and nearly 70% in the business districts of Beijing and Shanghai.[8] To achieve the country's emission reduction goal in its Nationally Determined Contribution, China has put great emphasis on energy conservation in the building sector. China aims to improve energy efficiency of existing buildings and promote the construction of green buildings to facilitate low-carbonized urbanization. Building materials is listed as one of the key areas to control emissions through energy conservation and efficiency improvement.[9]

Underpinning green building practices is the certification of green building materials, as they signify that the material will perform as advertised. Architects and developers can more easily comply with energy efficiency requirements if they have access to building materials with labels that clearly state their tested performance properties. Research has shown that a strong certification and labeling system can help lead to better building energy code implementation.[10] Code officials can more easily verify that materials match the code-compliant design if tested and labeled materials are used.[10, 11] Green-certified materials make it easier for many parties to ensure buildings are made from these products.

Recent policy documents in China highlight the importance of green building material certification and represent clear leadership by the government to use certification to facilitate transformation of the buildings sector. The General Office of the State Council, in order to increase the supply of high-quality green products into the buildings market, issued guidance to develop a uniform system for green product standards and certification by 2020.[1] The guidance stresses that this uniform system can stimulate market development by weeding out inefficient mechanisms and improving market efficiency. Example supporting measures are to strengthen cooperation and coordination between departments, improve supporting policies, cultivate an environment that favors green products, and strengthen the promotion of green products.[1]

The 13th Five Year Plan on Building Energy Efficiency and Green Buildings, released in February 2017 by MOHURD, set a high-level target to have green building materials in 40% of new buildings by 2020, while also striving to promote green building material certification.[12] The 13th Five Year Plan on Energy Saving and Environmental Protection Industry Development provides guidelines for the establishment and improvement of a uniform standardization, certification, and identification system for green products and services. A series of laws, regulations, rules, action plans, and financial supporting measures are designed to strengthen, support, and facilitate the establishment and implementation of energy-saving and environmental protection standards systems.[13] The 13th Five Year Plan on Strategic Emerging Industries puts great emphasis on promoting the development of highly energy-efficient industries through mandatory energy efficiency and energy consumption cap standards and an energy efficiency certification and labeling system.[14] The Ministry of Industry and Information Technology in its Industry Green Development Plan for 2016-2020 aims to press forward on improving energy efficiency in industry, of which building materials was identified as a key industry. Plans include phasing out outdated production facilities and dissolving excess production capacity by actively applying related environmental protection and energy consumption standards.[15] Excerpts of relevant plans can be found in Table 5 in the Appendix.

These guidance documents clearly recognize that certification programs can be a great tool for the construction of green buildings, and attention is given on important aspects such as uniformity and incentives that can greatly catalyze the uptake of certified products. The exact mechanisms of how all these actions are linked, however, has some ambiguity. Furthermore, it is fundamental that the foundation of certification is solid, such that certification programs themselves constitute a robust system of underlying process. There are many pieces that go into creating an effective certification program at the individual level and having it feed into the overall system in order to accomplish these ambitious building targets. If there is uneven implementation of building material standards, for example, the burden of compliance with different programs can disincentivize manufacturers to achieve certification for their products. And if labels do not match performance, the market value of high performance materials can be stunted.

This research paper will focus on the certification and testing system in China and the United States relevant to green building materials in order to identify areas for improvement and provide recommendations in China. To provide a basis for comparison, we also examined certification systems in both countries to identify shared features among programs that are indicative of a successful program. Examples of topics to be covered include governance and implementation, product testing and oversight, and promotion strategy.

2.0 Methodology

In this study, we are interested in the following key questions: 1) how elements of the system design contribute to a more robust testing and certification system for green building materials; and 2) what major barriers exist to making the system in China more comprehensive, consistent, and impactful in the buildings sector and what options are available to overcome these barriers.

We approach these questions by evaluating the system through three main categories: governance and implementation of the certification system; product testing and oversight; and strategies to increase the number of products certified. Under a consistent framework, we gathered information about current and

best practices in building material certification systems by exploring program websites, reviewing the literature, and conducting interviews with stakeholders around core questions.

This study is concerned with materials that contribute to the practice of green building, including but not limited to materials that lead to low consumption of natural resources (e.g., high operational energy efficiency, low embodied energy) and refrain from harmful effects on the environmental and human health (e.g., good indoor air quality). Among the many categories of products relevant to buildings, we focus on materials that are integral to the building's envelope. Example products that we cover are fenestration products (windows, doors, and skylights), roofing, tiles, and insulation.

The product certifications relevant to green building materials in the U.S. market and analyzed in this study include, but are not limited to, ENERGY STAR, the National Fenestration Resource Council (NFRC) program, Cradle to Cradle, and Green Seal. These certifications differ in a number of characteristics, such as their nature of governance, product coverage, and evaluation criteria, but they also have many in common. We examined properties of these systems across the various elements of a certification and testing system to identify these shared characteristics that are indicative of a successful program to uncover what can be considered as best practices.

This information is used to provide insight and recommendations on not necessarily the design of individual programs but the mechanism in which the system operates within the country. Whether we chose in this report to focus on programs regarding operational energy efficiency or embodied energy, or on certain categories of products, is largely irrelevant. Rather these programs and product categories are used as vehicles to analyze and comment on the system of green building material certification at large.

3.0 Results and Discussion

Certification labels can be divided into the two following groups: ones that identify products as meeting a specified minimum performance standard; and ones that label the property of the product irrespective of its performance. The process of certification is the method of providing assurance that a product conforms to whatever requirements are set forth by the program. For example, applied to green building materials, this would mean the certification of products against criteria such as energy efficiency, effect on indoor air quality, composition of sustainable materials, and adherence to sustainable practices. However, not all building material certifications relevant to green products have these minimum performance standards, and certifications that rate products along the spectrum of their performance can provide useful information for which to build programs, policies, and even other certifications upon.

Certification labels provide consumers an aspect other than price by which to compare products, thereby helping the consumer to make more informed choices and understand the different categories of performance. Labels are also a great tool for the implementation of building codes and building rating systems: they can help ensure that green building elements are incorporated at each stage of the construction process, including design, development, and compliance. Consequently, from a manufacturer's standpoint, labels are great marketing tools for their products and/or provide a means with which to comply with building requirements.

Because the core purpose of the label is its assurance of specific properties, the label derives the bulk of its value from the ability of its certification system to rate products consistently and accurately. This is not a trivial process. There are many elements and entities that need to be involved in order for this to occur, and careful planning is needed to execute a successful certification program.

Core to all certification programs is the need for a robust system to assess products for the specifications that the label reports or that the performance standards are set to (e.g., U-factor). Oversight is an important aspect of this system for ensuring that what the label stands for is accurate. Often there is in place a system of checks to ensure adherence, such as initial and verification testing, accreditation of laboratories, and post-market inspection. Promotion is important to accelerate and sustain market uptake of certified products. From the perspective of a government trying to elicit a profound change in the buildings market, it is desirable for certified products to have significant uptake and market share.

The primary bodies in a certification system – other than producers and consumers – include laboratories, standards developers, certifiers, and accreditors. Standard developers along with stakeholders create standards for testing, auditing, and performance. Laboratories test the materials according to testing standards to ensure the materials meet minimum standards or that what the label reports is accurate. Certifiers audit the laboratories and the certification process. Accreditors for laboratories and certification bodies provide additional oversight. Typically, laboratories, certifiers, and accreditors are independent parties, meaning that they are independent from each other as well as the product manufacturer, contractor, designer, and other parties that may have a vested interest.

Common practice is to document requirements, specifications, guidelines, or characteristics such that they can be applied in a consistent and transparent way. Certified products at their core are supposed to vouch for the product's property, and standards are a way to ensure their integrity is upheld. Standards are utilized by certification systems in almost every aspect of operation, such as developing product specifications and testing procedures, accreditation of laboratories and certification bodies, and developing methods for third-party certification bodies to ensure requirements of the program are met. Standards developed through a formal, voluntary, and consensus process are more likely to have buy-in, government support, and international influence.

Oftentimes certification programs use the infrastructure of national and international standards organizations to leverage their expertise and to give certification programs more authenticity. For example, ISO/IEC 17025 "General requirements for the competence of testing and calibration laboratories" is the main International Organization for Standardization (ISO) standard used by testing laboratories. In many countries, ISO/IEC 17025 is the standard for which most labs must hold accreditation.i

3.1 Governance and Implementation of Certification Systems

While in general most certification systems share similar elements, their exact implementation can vary significantly from program to program. Moreover, because government policy plays an important role in certification, implementation can vary greatly among countries. In this section, we examine the properties of these certification programs across the various elements of a certification system and assess the effect of governance on their implementation.

"The system of governance of certification systems in China differs significantly from United States in that the Chinese government and certification groups play a more prominent role in the creation and management of certification programs and standards."

3.1.1 United States

The United States certification system is to a great extent market driven and voluntary. There are multiple standards developing organizations in the country, each working in response to a specific need in the marketplace, and it is generally up to the marketplace to choose standards that best meet market needs. The private sector-led U.S. voluntary standardization and certification systems rely heavily on the active participation and engagement of all affected stakeholders, both public and private.

For example, the National Fenestration Rating Council manages the eponymous label for fenestration products and is nonprofit, public/private organization created by the windows, doors, and skylights industry. The NFRC label does not set minimum performance standards and therefore does not identify energy efficient products. NFRC is an American National Standards Institute (ANSI) standards developer and adheres to the ANSI process for developing testing and programmatic standards for their certification program.

ANSI is a U.S. representative to the ISO and facilitates the development of standards. Standards developers accredited by ANSI, for example, need to adhere to the ANSI process and their principles of consensus. There are more than 200 ANSI-Accredited Standards Developers. Standards by ISO, ANSI, ASHRAE, ASTM, and NFRC are common in the field of building materials.

ENERGY STAR, which is managed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA),[16] is one of the most prolific green certification programs in the United States. The program is managed by the government but relies heavily on third-party testing and certification and involvement by the private sector on the creation of standards. The program certifies over 30 product categories according to energy efficiency operational standards and covers fenestration products, roofing products, sealant, and insulation in the building materials area.[17] While ENERGY STAR and NFRC both concern the energy performance of fenestration products, only ENERGY STAR identifies products as being energy efficient. All ENERGY STAR-qualified windows, doors, and skylights, however, must be independently tested, certified, and verified according to test procedures established by NFRC.[18] This is actually a requirement by law according to the National Technology Transfer and Advancement Act, in which U.S. federal agencies must use technical standards developed by voluntary consensus standards bodies if practical instead of creating their own.[19]

The American Architectural Manufacture's Association (AAMA) certification program certifies fenestration products in both the residential and commercial sectors. The AAMA Gold label certifies products according to structural, air, and water performance requirements, while the AAMA Silver label certifies products according to thermal performance. Products for the AAMA Silver Label are tested to either the AAMA 1503 test method or to NFRC-100 requirements.[20]

In the U.S. windows industry, for example, there is generally good coordination in testing and performance standards among the different certification programs. Alignment of standards across this industry promotes fuller participation from manufacturers without the tradeoff of a bigger burden of compliance.

3.1.2 China

All certification systems in China are overseen by the government ministries, Ministry of Housing and Urban-Rural Development (MOHURD), Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ), and the Ministry of Industry Information Technology (MIIT). AQSIQ contains the Certification and Accreditation Administration of China (CNCA), which houses protocols for certification and accreditation, and the Standardization Administration of China (SAC), which oversees the administration of standards. Prominent programs are created and managed by the national government, but their implementation is spread across multiple certification groups. Also, under the voluntary certification system, accredited institutions can issue their own certifications, but these are still overseen by the government. Standards, which underpin the operation of these certification programs, can be created by the national government, industry associations, and certification bodies. The system of governance of certification systems in China differs significantly from United States in that the Chinese government and certification groups play a more prominent role in the creation and management of certification programs and standards. Instead of being driven by the private sector, leadership is more spread out to include certification groups and the government.

The Chinese certification programs follow national standards (mandatory or voluntary), industry standards, and/or technical specifications. For example, the China Compulsory Certification (CCC) program follows mandatory national standards. The Energy Conservation Certification, the Water Conservation Certification, and the Environmental Label follow national standards, industry standards, or technical specifications.

CNCA's rules allow certification organizations to develop technical specifications if there are no standards available or applicable. New technical specifications developed by certification organizations must be registered with CNCA.

The State Council's administrative authority for standardization leads the work on national standards. It first makes the plan and assigns tasks of standard development (and/or revision) to related organizations, then approves the standard, numbers it in line with other national standards, and finally publishes the standard. Industry standards are developed by the State Council and the ministries responsible for the concerned industries. In addition, the China Association for Engineering Construction Standardization is developing the Green Building Materials Certification Standard. The Housing Industrialization Promotion Center within MOHURD is leading the drafting of this standard with the help of other institutions including the China Academy of Building Research (CABR), China Building Material Test & Certification Group Co., Ltd (CTC), and the China Building Material Academy.

The development of standards can help make effective use of national resources, promote technology deployment, generate economic benefits, enhance security and public health, protect consumer interests, conserve the environment, enable interchange of products, and improve compatibility among standards.

National standards are reviewed after implementation when appropriate as technology advances and the economy grows. For each national standard, reviews take place at least once every five years to ensure its applicability to state-of-art product performance and testing methods, among other aspects. The review of results determines whether the standard needs revision. For standards that do not have to be revised, the review and approval committee will certify their effectiveness forward. Standards with a need for revision can be reported as revision projects under the National Standard Revision Plan. Standards that are no longer applicable will be recommended for termination by the related technical committee or department.[21] Technical specifications for certifications need to be reviewed (and revised if necessary) three years after publication. Certification organizations need to revise technical specifications when there is significant technology advancement and/or upgrade of products, or when there is revision in referenced standards. The revision of technical specifications should comply with related requirements and follow a rigorous approval procedure.

Currently, building material-related certification in China includes CCC, Resource Conservation (e.g., energy and water conservation) Certification, China Certification for Environmental Products, Low Carbon Products Certification, Green Building Material Assessment Label, Type II Environmental Labeling, Type III Environmental Labeling (Environmental Product Declaration), and China Fenestration Energy Efficiency Performance Labeling.

The Regulation concerning Management of Compulsive Product Certification, released by AQSIQ in December 2001, substitutes compulsive product certification system for previous security and quality licensing system for imported products and security licensing system for electro-technical products. CCC, as the name implies, is a legal compulsory certification system. Products listed in the compulsory certification category cannot be marketed, sold, imported, or used for any commercial purposes without acquiring a certificate issued by accredited certification authorities. The certification currently is required for products in 22 categories and 159 subcategories. Building material products in the product catalog for compulsory certification include, for example, architectural safety glass, solvent furniture paint, concrete anti-freezer, and porcelain tile.

Resource Conservation is voluntary, and certification organizations have the autonomy to carry out their own programs. The Energy Conservation and Water Conservation Certification program is one of the more influential ones and is carried out by the China Quality Certification Center (CQC). The Energy Conservation Certification covers, for example, electric appliances, office equipment, lighting products, electromechanical, electric transmission and transformation equipment, and building materials. The Water Conservation Certification applies to industrial water treatment, water usage in urban areas, irrigation and drainage, unconventional water resources utilization, and so forth. The aim of this certification is to promote the consumption on energy-saving and water-saving products and push for the technological innovation and improvement of energy-saving and water-saving products. Building material products covered by this certification include, for example, doors and windows, hollow glass, aluminum architectural profile, and inorganic thermal insulation products.

Environmental Products Certification is voluntary and mainly refers to China Certification for Environmental Products, which is accredited by CQC, and the China Environmental Labeling (often called “Ten Ring Certification”), accredited by China Environmental United Certification Center Co., Ltd. This certification aims to promote the production and usage of environmentally friendly products, improve the living condition and natural environment, and achieve the sustainable development. Building material products covered by this certification include, for example, paints, artificial boards, wallpaper,

binders, ceramic tiles, carpet, concrete admixture, and wooden doors. The Environmental Labeling indicates that the product not only conforms to relevant quality standards but also adheres to specific environment protection requirements with low toxicity and energy-saving properties. Accredited by the Ministry of Environmental Protection, China Environmental United Certification Center covers, for example, water-based paints, solvent-based coatings, wooden boards, adhesives, wallpaper, ceramic tiles, sanitary wares, doors and windows, cement, concrete, and wall planks.

NDRC and CNCA jointly issued the Interim Measures for the Administration of Low-Carbon Product Certification on Feb 18, 2013 to push forward the realization of the greenhouse gases emission target by 2020, to regulate low-carbon product certification, to promote international trade, and to protect the interest of relevant domestic industries. On September 17, 2015, NDRC and AQSIQ jointly published the Measures for the Administration of Energy-Saving and Low-Carbon Products Certification to speed up the improvement and popularization of energy-saving and low-carbon techniques and to reduce greenhouse gases emissions. Enacted on November 1, 2015, the first batch of products enlisted in certification include general purpose Portland cement, sheet glass, aluminum alloy proximate matter for buildings, and three phase asynchronous motors. The second batch of products includes ceramic tile or board for buildings, tire, and textile fabric. More products are expected to be enlisted in the low-carbon product certification catalog.

The Green Building Material Assessment Label accredits building materials according to five dimensions: energy conservation, emission reduction, safety, convenience, and recycling throughout the whole lifecycle. The label has a three-tier system based on performance (one-star, two-star, and three-star from low to high rank). MOHURD and MIIT administer the evaluation and labeling of three-star products, while their provincial-level departments (i.e., HURD and IIT) are responsible for labeling one-star and two-star products in their respective jurisdictions. The first batch of the Green Building Material Assessment Label was released on May 27, 2016 pursuant to policies such as Several Opinions on Further Strengthening the Administration of Urban Planning and Construction, Made in China 2025, and Green Building Action. Seven categories of products are assessed currently, including masonry materials, insulation materials, premixed concrete, energy-saving glass for buildings, ceramic tiles, sanitary wares, and pre-mixed mortar, and more product categories will be included in the future. The assessment is implemented by multiple certification agencies accredited by government authorities.

As an informational label, the Fenestration Energy Efficiency Performance Labeling provides objective descriptions on the U-value, shading coefficient (solar heat gain coefficient (SHGC)/0.889), air permeability, visible light transmittance, and other energy-saving performance metrics. Pursuant to the Measures of the Administration on Pilot Projects of Fenestration Energy Efficiency Performance Labeling, this label aims to ensure the energy-saving performance of fenestration products, to regulate the fenestration product market, to promote the technological improvement in energy conservation for buildings, and to enhance the energy efficiency of buildings. The Research Institute of Standards & Norms housed in MORHURD is in charge of the implementation of the label.

3.1.3 Area for Improvement and Recommendation: Better streamline certifications for individual product categories

The decentralization of leadership can often lead to product categories covered by multiple certifications and/or performance standards. Oftentimes a group may spot a need in the market for a single attribute,

such as CO2 emissions or safety, and issue a certification covering that one aspect. Each certification institution can have their own rules and standards to achieve their respective certification. For example, accredited institutions labeling energy-saving windows and doors include the Shanghai Ingeer Certification Assessment Co., Ltd (ICAS), CQC, CTC, and China Quality Mark Certification Group (CQM), with each having their own rules for implementation that may vary.

While many of these certifications have come about to recognize products across a range of prices and attributes, the large number of unconnected certifications for a single product category may confuse the consumer and increase burden to manufacturers who seek to distinguish their products. For the sake of competition, manufacturers may elect to achieve multiple certifications and conform to their respective requirements, but in doing so they would incur operational and opportunity costs, which could have been invested in technology innovation, quality improvement or cutting costs.

Likewise, consumers may suffer from the large number of certifications. Given so many different labels for the same product class, it can leave consumers confused. For example, both CTC and Guojian Lianxin Certification Center (GJC) conduct certification for molded polystyrene board (EPS) insular systems. While the testing standards for both certifications are based on the industrial standard, JGJ144 (technical specification for external insulation on walls), there is no guarantee that the EPS external wall materials with the CTC and GJC label have comparable thermal resistance properties, because only the CTC rule requires testing of thermal resistance.

Moreover, consumers not keen on energy conservation and other green attributes might question the credibility of green products in general and interpret various green building material labels as business promotion tools without any real value. Besides, as mentioned before, the increased effort can inflate the price for green building materials, further discouraging consumers from choosing them.

It would be helpful to streamline certifications for a number of reasons, including lowering the burden to manufacturers, increasing consumer awareness, and creating better market acceptance.

China has begun to integrate the various green product certification programs. Article 46 of the Overall Plan of the Reform of the Eco-civilization System states that a uniform green product system will be set up. Environmental-friendly, energy-saving, water-saving, recyclable, low-carbon, renewable, and organic products will be unified under the designation of green products. A uniform standardization, certification, and labeling system will be built, and initial progress has already been made.

3.1.4 Area for Improvement and Recommendation: Greater alignment among performance standards

Similar to the issue with the number of certifications, there is an overlapping of performance standards such that multiple performance standards exist on the same category of products, without due justification such as to reflect differences in climate. Performance standards can be created by the national government, industry associations, and certification groups if they deem existing standards to be inadequate for their program. Overlapping standards for a product class can lead to a fragmented system in which different aspects of the building sector use different standards. From the perspective of the manufacturer, this can be a burden when both trying to distinguish and enter markets for their green products.

It is beneficial to market uptake if standards can be aligned with each other and/or other programs, such as building energy codes. Alignment of performance standards can accelerate the uptake of green products by overcoming market barriers, reducing costs, and speeding time-to-market.

It is recommended for the standard developers, such as government (both national and subnational), industry associations, and certification groups to align their performance standards whenever feasible.

3.1.5 Area for Improvement and Recommendation: Inclusion of product categories that presently have no coverage from an existing certification program

Some products important to the green building sector have no relevant certification program, such as energy-efficient window coatings. A gap in coverage of product classes can lead to lower overall market penetration of certified-products and limit the potential of the building to be more fully composed of high-performing products. It is recommended to expand existing programs to cover these and other green building materials to improve market penetration, especially if these green building materials have a relatively large impact on the overall properties of the building.

Table 1: Governance and implementation metrics for U.S. window certifications

Certification Program	Extent of Industry Participation	How Industry is Informed on How to Participate	Extent and Nature of Overlap Among Certifications	Number of Relevant Certification Programs for Energy Efficiency
ENERGY STAR	Includes stakeholder engagement to develop performance specifications and their reassessment as market conditions change	Schedule on website; letters sent to stakeholders; partners can access information through their My ENERGY STAR Account (online portal)	ENERGY STAR uses NFRC testing to determine performance	3 (ENERGY STAR, NFRC, AAMA)
NFRC	ANS Standards Committee includes producers, users, and general interest groups to oversee review process; Industry can also become a member	Schedule on website; application to join committee available on website	ENERGY STAR uses NFRC testing to determined performance	
AAMA	AAMA is an ANSI-accredited standards developer, which means that document creation is a consensus-based process	Not found	To determine thermal performance, products may be tested according to AAMA or NFRC test methods	

Table 2: Governance and implementation metrics for Chinese window certifications

Certification Program	Extent of Industry Participation	How Industry is Informed on How to Participate	Extent and Nature of Overlap Among Certifications	Number of Relevant Certification Programs for Energy Efficiency
Energy Conservation Certification	Stakeholders, including industry, are engaged before the finalization of the technical specifications. Also, guidelines and regulations are also subject to change according to opinions of stakeholders.	Not specified how comments are solicited	None	6 (China Fenestration Energy Efficiency Performance, Green building assessment label, ICAS, Energy conservation certification, CQM, CTC)
China Fenestration Energy Efficiency Performance	Relevant stakeholders could contribute to the performance testing and evaluation specifications before the testing standards are finalized by the Research Institute of Standards & Norms or the National Technical Committee on Curtain Walls and Windows of SAC. But there are no direct channels to engage industry participators and the public during the certification and labeling process.	Notice soliciting public opinions on standards are put on government websites. The information is dispersed in various websites and can be difficult to navigate for those who are unfamiliar with this system. Comments should be mailed to certain government agencies within a short period of time.	None	
Green Building Material Assessment	The public can file complaints against accredited testing organizations or certified manufacturers.	Information about accredited testing organizations and manufacturers are publicized online for the public to file complaints or raise doubts about the certification.	None	

3.2 Product Testing and Oversight

Certification bodies, testing laboratories, and inspection bodies have a critical role to play in assuring that products, personnel, and services comply with testing standards. Many building material certification programs concern specific properties of materials, such as thermal conductance for windows and off-gassing from indoor products. Therefore, testing is necessary for these certification programs to ensure accurate reporting or that the product meets the minimum requirements of the certification. A robust testing process has many aspects that need close attention with a comprehensive system of oversight, including, for example, clear and viable testing protocols, verification testing, and oversight of the laboratories.

"Best practices are where a common testing standard for a product property is followed for a class of products, regardless of the specific certification program. …disparate testing protocols can make it difficult to objectively compare products and inhibits a common platform from being used to make transformative changes in the market."

3.2.1 United States

Nearly all certification programs in the United States subject their testing protocols through an ANSI-standard development process, meaning it is subjected through a voluntary, consensus-based process. The most rigorous certification programs also have standards for their mechanism of oversight. Testing and oversight is usually done at independent laboratories and certification bodies. Laboratories need accreditation, and the audit processes of the laboratory are conducted by a certification body. Both ENERGY STAR and NFRC use a system of third-party certification bodies, and great effort is taken to ensure laboratory results are consistent within their respective programs.

NFRC has developed standard procedures for the execution of its rating, certification, and labeling program, including testing (NFRC 100-500),[22] laboratory accreditation (NFRC 701),[23] and compliance and monitoring (NFRC 707).[23] NFRC has a comprehensive oversight mechanism involving NFRC-licensed responsible parties to reinforce the system, the activities of which are governed by these standard procedures. Laboratories that perform NFRC tests and simulations must meet the criteria set forth under NFRC's Laboratory Accreditation Program (LAP), which establishes rules and regulations for assuring that test and simulation labs are providing uniform ratings. LAP requires periodic review and proficiency testing for certification maintenance and accreditation renewal. Testing and simulation laboratories must meet program requirements, demonstrate continued competence, participate in laboratory workshops, and participate in annual inter-laboratory comparisons. NFRC inspection by independent agencies conducts initial and bi-annual laboratory site inspections, annual evaluation of laboratories, blind competence evaluations, coordinates inter-laboratory comparisons, and conducts laboratory workshops. Moreover, LAP requires independence of the laboratory to both NFRC and window manufacturers, suppliers, and vendors.

ENERGY STAR, aside from employing NFRC testing standards for its fenestration products, uses ASTM test methods for its roofing and insulation products.[24, 25] These ASTM tests concerning the thermal resistance (i.e., R-value) are required by the Federal Trade Commission on almost all insulation products to provide apples-to-apples benchmarks for comparisons. These tests are conducted at a third-party EPA-recognized laboratory, wherein ENERGY STAR requires participation in inter-laboratory comparison testing or proficiency testing. ENERGY STAR uses a system of third-party certification to follow a verification process that includes verification testing, reevaluation in the event of significant changes, challenge testing, and reporting changes in product performance.[26]

ENERGY STAR also employs post-market verification testing. Every year, the EPA provides certification bodies with nominations for verification testing in each product category, which comprise up to half to the certification bodies' total testing responsibility in that category. The remainder is selected

randomly along their portfolio with a minimum of 5% of unique models for windows, doors, and skylights and 10% of unique models for roof products.[27] ENERGY STAR imposes enhanced oversight of categories of products and manufacturers that have disproportionately high failure rates.[28]

3.2.2 China

CNCA is the primary government agency supervising conformity assessment and lab accreditation. Two organizations provide oversight of testing labs and provide accreditation, China Metrology Association (CMA) and China National Accreditation Service for Conformity Assessment (CNAS). CNAS uses ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories" to ensure the consistency of testing results across labs, improve labs' quality control, and reduce potential quality risk. Per CNCA's requirements, certification organizations need to supervise the testing labs in their certification programs to make sure testing results are robust.

Moreover, the State Council published the Integrated Reform Plan for Promoting Ecological Progress on September 18, 2015. Article 46 of the Plan specifies "Establishing a uniform green product system: integrate existing certifications of environmentally friendly, energy conservation, water conservation, recyclable, low-carbon, renewable, and organic products into green products; establish a uniform scheme of standards, certifications, and labels for the green products; improve policies and financial incentives in research and development, production, transportation, purchase and use, as well as government procurement of green products."845

The implementation of the Plan can ensure consistency of reference standards, certification process, and protocols, among other things. Most testing labs need two credentials. Product certifications (or labels) in China are usually only valid for a certain period of time (often three years) with annual inspection to ensure the robustness of certification. For instance, the Water Conservation Certification is valid for three years, with regular site inspection(s) of the manufacturing facility and a sampling check of the product each year. The manufacturer is required to conduct an internal examination for product uniformity at least once per year.

3.2.3 Area for Improvement and Recommendation: Greater uniformity in testing protocols for a specific product property

Subjecting a class of products to the same testing process enables better comparisons to be made among products on a specific and often important metric. Multiple testing standards could, for example, decrease the ability of code inspectors to determine compliance with a building code. Best practices are where a common testing standard for a product property is followed for a class of products, regardless of the specific certification program. On the other hand, disparate testing protocols can make it difficult to objectively compare products and inhibits a common platform from being used to make transformative changes in the market.

Similar to the recommendation for a greater alignment among performance standards, it is recommended that different institutions, including local and national governments, align their testing protocols and requirements whenever feasible, such as to national standards. Additionally, uniformity of testing could be encouraged by linking with building requirements such as building codes and building rating systems.

3.2.4 Area for Improvement and Recommendation: More consistency in testing results among laboratories

One potential issue is the lack of adequate laboratory oversight among certification centers within the same system. Although there are programs monitoring results across laboratories, documented requirements on ensuring consistent testing results among laboratories could not be found. Best practices are where laboratories must participate in periodic inter-laboratory comparisons, participate in blind competence evaluations and other validation measures. Furthermore, clear independence is needed among certification groups, laboratories, developers, and manufacturers to avoid potential conflicts of interest.

Four certification centers, for example, perform three-star certifications for MOHURD's Green Building Materials Assessment Label. While each certification center may have oversight among their testing labs, protocols for inter-laboratory comparison among the centers themselves could not be found. Furthermore, there is inherent dependence between the certification centers themselves and their laboratories, and there does not exist clear independence between the two bodies, such that there may exist a conflict of interest.

Table 3: Product testing and oversight for U.S. window certifications

Certification Program	Properties Rated (mandatory)	Testing Standard	Documented Inter-laboratory Comparison Measures	Number of Relevant Certification Programs for Energy Efficiency
ENERGY STAR	U-value, SHGC	NFRC 100, 200*	Not applicable (uses NFRC rating)	3 (ENERGY STAR, NFRC, AAMA)
NFRC	U-value, SHGC, Visible Transmittance, Air Leakage	NFRC 100, 200, 300, 400	Laboratory Accreditation Program (NFRC 701)	
AAMA	U-value, Condensation Resistance, Air Leakage, Water Leakage, Structural Strength	AAMA/WDMA/CSA 101/I.S.2/A440; AAMA 1503 or NFRC 100 (for thermal performance)**	May use NFRC rating	

* NFRC testing standards include simulation and/or physical testing, depending on the exact type of product. For simulation and physical testing, these NFRC standards reference ISO and ASTM standards and use NFRC environmental conditions.

** Manufacturers may certify product thermal performance to either the AAMA 1503 test method or to NFRC-100 requirements. Products tested for thermal performance only are eligible for the AAMA Silver Certification Label, but the Gold Label certification requires testing according to the basic structural, air, and water performance requirements.

Table 4: Product testing and oversight for Chinese window certifications

Certification Program	Properties Rated (mandatory)	Testing Standard	Documented Inter-laboratory Comparison Measures	Number of Relevant Certification Programs for Energy Efficiency
Energy Conservation Certification	Air Leakage, Thermal Insulation Property (Heat Transfer Coefficient), Shading Properties (Visible Light Transmittance, Shading Coefficient)	CQC3118-2011 Energy conservation certification criteria for window, doors and curtain walls	None	6 (China Fenestration Energy Efficiency Performance, Green building assessment label, ICAS, Energy conservation certification, CQM, CTC)
China Fenestration Energy Efficiency Performance	U-Value, SHGC, Air Leakage, Visible Transmittance	Glass optical and thermal properties are tested according to national standards GB/T 2680, and industry standards JGJ/T 151; testing of heat transfer coefficient is based on the existing national standards GB/T8484; air permeability property testing is based on existing national standard GB/T 7106	None	
Green Building Material Assessment	U-Value, Visible Transmittance, SHGC, Heat Transfer Coefficient, Energy Consumption Per Unit Product/Carbon Emission; Energy Consumption During the Transportation of Raw Materials; Energy management system	None	None	

3.3 Strategies to Increase the Number of Products Certified through Linking with Policies and Incentives

Labels provide consumers an aspect other than price for which to compare products, thereby helping the consumer to make more informed choices and understand the different categories of performance. High participation rates extend these benefits industry-wide.

"While constructing green buildings is a basic national policy in China, there is limited public awareness of the economic and health benefits of green buildings in China."

Building material certification can be an integral tool when linked to programs and policies such as building energy codes and building rating systems. Certified-products can help designers meet a prescriptive requirement of a code, construction companies install specified materials, and building inspectors with compliance, thus increasing the chances for effective enforcement. The label facilitates inspection by matching the label to the approved design without the need for time-consuming validation testing of a product sample. Linking certification with building energy codes has the potential to both influence a large number of sales and be cost effective. Furthermore, another way to incentivize manufacturers to obtain

certification and/or meet a performance standard is to standardize building energy codes and rating systems so that a product can easily comply with multiple programs concurrently, thereby reducing the burden to manufacturers.

Incentivizing certified-green building materials can increase their market penetration by spurring and cementing program participation by both manufacturers and consumers. Incentives can be financial, such as tax deductions/credits, rebates, and loans or non-financial, such as training, advertising, priority permitting, and inclusion on procurement lists. Incentives can specify particular certifications, share the same criteria of performance, or they can promote green materials more generally.

3.3.1 United States

Certified-building materials in the United States enjoy a high market share in certain product categories. ENERGY STAR estimated that in 2014 ENERGY STAR-certified roofing products made up 40% of the U.S. market (41% for residential, 39% for commercial), and its fenestration products made up 82%.[29] Because ENERGY STAR uses the NFRC certification for its fenestration products, the market share for NFRC-certified products would be equal or higher to that of ENERGY STAR. In addition, NFRC certification is referenced in the model code (i.e., ASHRAE 90.1 and IECC), which helps increase market penetration of the certification and facilitate code implementation at the same time. Together the public and private sectors form a wide-ranging strategy to promote the certification and testing of a large share of products.

All major standards and programs for window energy efficiency — including building energy codes, tax credits and utility incentives, ENERGY STAR, and others — base their criteria on NFRC-certified ratings. Most residential energy codes in the United States require either NFRC ratings or direct manufacturers to use default values.[30] Default values in the codes are meant to be punitive, and, in many climate zones, default values for U-factor and SHGC do not meet the code requirements. Because code inspectors in many cases cannot evaluate onsite whether the product is energy efficient, the punitive default values encourage the use of labels.

The R-rule of the Federal Trade Commission requires insulation manufacturers and sellers to disclose the performance of virtually all their insulation products based on uniform testing procedures. The value for resistance to heat flow (R-value) is to be clearly and conspicuously labeled. The testing procedures for the determination of the R-value were designed by ASTM.

Tax credits, until very recently, were available to homeowners for retrofitting projects with roofing, insulation, and fenestration products. The Federal Energy Management Program, which maintains acquisition guidance for federal agencies, includes ENERGY STAR products for roofing and fenestration products.[31] The U.S. Green Building Council uses current ENERGY STAR criteria for windows as the prerequisite for LEED certification.[32] Furthermore, ENERGY STAR-certified roof products are eligible for points in LEED v4.[33]

3.3.2 China

The Chinese government developed several policy incentives to promote building material certifications. For example, the government procurement list for energy conservation products and the government

procurement list for green products endorse certified energy conservation, water conservation, and/or environmentally friendly products.

Certified low-carbon products are eligible for subsidies provided by local governments. Article 5.2.3 of GB/T 50378-2014 "Assessment Standard for Green Buildings" specifies that a building can add 5 to 10 points when its thermal performance is better than the envelope requirements in the current building energy codes. This Article provides advantages for products with Green Building Material Assessment Label or Energy Conservation Certification in the bidding of green building projects. Many green building and/or healthy housing projects even have mandatory requirements to use products with Green Building Material Assessment Label.

Green building materials represent a small percentage of the total building materials market in China.[34] Furthermore, because building code enforcement is inconsistent across locales, developers may have little incentive to use legitimate green building materials. Suppliers may certify materials without complying with requirements. Evans et al. in 2010 deemed policy support for promoting labeled products still insufficient in China.[35] While constructing green buildings is a basic national policy in China, there is limited public awareness of the economic and health benefits of green buildings in China. The impact may be that developers are unable to capture the benefits of building green in marketing to future tenants.

3.3.3 Area for Improvement and Recommendation: Stronger promotion strategy to get more products certified, including linkages to policies and certifications, demonstration projects, and energy-efficiency monitoring

The existing promotional strategy for green building material certification mainly focuses on government initiatives, projects, or procurements. Regulation on the Green Building Material Assessment and Labeling program, which was issued in May 2014 by MOHURD and MIIT, laid out general rules to encourage the application of certified green building materials mainly through government-sponsored projects. According to this regulation, newly-built, renovated, and expanded construction projects are encouraged to give priority to certified green building materials. And green building materials should be used in green buildings, ecological urban areas, or other government-sponsored construction projects. At the provincial level, Anhui,[36] Shandong, and Henan provinces incorporated some promotion strategies for certified green building materials in their local implementation regulations. Shandong province, for example, requires government-sponsored projects such as governmental buildings, security housing, and public welfare construction to prioritize the use of certified green building materials in construction.[37] Henan province requires that green building projects within their jurisdiction to utilize certified green building materials.[38]

The Chinese government has recently identified a set of strategies to further promote the production and application of green building materials. The Action Plan for Promoting the Production and Application of Green Building Materials aims to steadily increase the proportion of green building materials used in construction and renovation: the share of green building materials should account for 30%, 50%, and 80% in new buildings, green buildings, and the reconstruction of existing buildings, respectively. Specifically, MOHURD and MIIT issued guidelines to promote the application of green building materials in rural areas and pilot or demonstration projects.[39] The Plan calls for actions to study and formulate supporting policies. Financial incentives related to tax and price will be created to boost the production and

consumption of green building materials. The government will help initiate special funds for the development of green building materials that provide low-interest loans to manufacturers. Financial subsidies will be provided to deploy green building materials in rural areas, and certain green building material manufacturers may benefit from preferential value-added-tax deductions.

The 13th Five-Year Plan on Building Energy Efficiency and Green Buildings, released in February 2017 by MOHURD, set a high-level target to have green building materials in 40% of new buildings by 2020.[12] While this plan also strives to promote green building material certification, the precise mechanism of how to meet the high-level target – and the role that certification will play and how it will be promoted – remains unclear.

Linking certification with building energy codes, which has been discussed earlier, can be very effective in linking certified products with the construction process. Also, the cost of heating in most parts of China is priced according to the floor space of the building rather than the energy consumed. Therefore, building owners have no incentive to use energy-efficient materials such as insulation because the heating charge is fixed whether or not the building space is energy efficient. If policy associated the heating charge with energy use, people would also have an economic reason to use energy-saving building materials.

3.3.4 Area for Improvement and Recommendation: Greater number of products certified by instituting a continuous or graded certification scheme

Preliminary development of the uniform certification system appears to restrict certification to the top 5% of products, as indicated in a draft of the General Rule on Green Product Assessment, issued by SAC in November 2016 to solicit public opinion. Section 5.4, Rules for Determining the Reference Value of Indexes indicates that the threshold to achieve certification should be set so as only 5% of the products in the same category shall meet the standard. The motivation of setting such a high standard would be to showcase superior products.

Although restricting certification to a small subset of products can help consumers identify high performance products and encourage manufacturers improve their product quality, doing so also has its disadvantages. This can make it difficult for smaller manufacturers that may not be able to produce products in the top echelon of performance or those that compete in the marketplace on other attributes, such as aesthetics. An alternative to lowering the threshold to achieve certification would be to have a continuous or tiered labeling system can be used to better encourage the participation of all products in the class, while still giving commensurate recognition to the best products.

Table 5: Strategies to increase certification of products for U.S. window certifications

Certification Program	Linkages to Building Codes	Linkages of Building Rating Systems (specifically LEED for the United States)	Incentive - Federal Procurement List	Incentive - Tax Deduction/Credit
ENERGY STAR	IECC 2015 uses NFRC rating for U-value and SHGC or default value	Separate from LEED.	Energy Policy Act of 2005 requires federal agencies to buy either ENERGY STAR products or products designated as energy efficient by Federal Energy Management Program	Up until end of 2016, fenestration, roofing, and insulation products were eligible for tax credit
NFRC	IECC 2015 uses NFRC rating for U-value and SHGC or default value	NFRC-rated U-factor and SHGC used for LEED prescriptive path points	Shares same incentive as ENERGY STAR by virtue of NFRC underpinning the program	Up until end of 2016, fenestration products meeting ENERGY STAR Windows Program version 6.0 were eligible for tax credit
AAMA	IECC 2015 uses NFRC or AAMA for air leakage	Unknown	Unknown	Unknown (does not measure SHGC)

Table 6: Strategies to increase certification of products for Chinese window certifications

Certification Program	Linkages to Building Codes	Linkages of Building Rating Systems (specifically LEED for the United States)	Incentive - Federal Procurement List	Incentive - Tax Deduction/Credit
Energy conservation certification	None	None	Companies must acquire the Energy conservation certification to be included in the government procurement list of energy saving products.	None
China Fenestration Energy Efficiency Performance	None	Energy efficiency labeling information should be taken into consideration in the building energy efficiency evaluation and project bidding process.	Products with China Fenestration Energy Efficiency Performance label are given priority on programs financed by public funds like government office building, large-scale public building, and affordable housing.	None
Green building material assessment	None	Green building program, green eco-cities	None	None

4.0 Conclusions

This report investigates the certification and testing system in China and the United States relevant to green building materials in order to identify areas for improvement in the Chinese system and provide recommendations. There is clearly a lot of activity in China in the area of green buildings, and we hope to turn the attention of relevant standards and certification entities to the areas that we have found to be particularly important. Table 7 lists the areas identified for improvement and summarizes the corresponding recommendations.

Table 7: Summary of areas for improvement and corresponding recommendations

Area for Improvement	Recommendation
Greater uniformity in testing protocols for a specific product category	• Use a standard testing protocol or link a certification program to a building energy code to encourage materials in the same product class to undergo the same testing protocol • Have certification programs require testing methods to follow national or industrial standards • Ensure better uniformity in testing protocols among local governments and between local and national governments for building energy codes/rating systems and national programs
More consistency (or better assurance) in testing results among laboratories	• Institute more robust inter-laboratory comparisons, such as periodic comparisons and blind competence evaluations
Better streamline certifications for individual product categories	• Reduce number of certifications or standardize requirements for individual product categories • Replace and consolidate existing certification programs such as energy certification and low-carbon certification with green certification with different grades • Obtain more participation from industry in the development process, including having clear ways to engage stakeholders
Greater alignment among performance standards	• Better coordinate among standards developers, such as government (both national and subnational), industry associations, and certification groups to align their performance standards to the maximum extent possible • Avoid creating new performance standards unless due justification such as differences in climate, and consider the tradeoff
Inclusion of product categories that presently have no coverage from an existing certification program	• Extend certification to products important to the green building sector but not covered by an existing program, such as energy efficient window coatings and construction building blocks • Prioritize the development of certification programs based on the quantity of building materials that are used in the market (e.g., building materials that account for over 20K tons/year) and gradually expand to other product categories over time

Stronger promotion strategy to get more products certified, including linkages to policies and incentives	• Link certification programs to policies (e.g., building energy codes)
	• Offer stronger incentives, such as the following:
	  ○ Financial (rebates, tax deductions/credits, ability to bid on government contracts)
	  ○ Nonfinancial incentives (priority permitting)
	• Institute demonstration projects
	• Promote energy-efficiency monitoring, including charging building owners according to energy consumed and not floor space

Greater number of products certified by instituting a continuous or tiered certification scheme	• Introduce a continuous or tiered certification scheme to better encourage the participation of all products in the class while still giving commensurate recognition to the best products • Encourage manufacturers to supplement certification by making self-declarations, supported by testing from accredited laboratories, for products that far exceed the standards set by certification

Appendix

The following high-level government plans in China related to green building materials were discussed in this report: 13th Five Year Plan on Energy Saving and Environmental Protection Industry Development; MIIT Industry Green Development Plan; Guidance on Establishing a Uniform Standardization, Certification, and Identification System for Green Products by the General Office of the State Council; and the 13th Five Year Plan on Strategic Emerging Industries. Table 8 provides excerpts from these reports related to the areas of standardization, certification, and labeling.

Table 8: Excerpts of recent high-level governmental plans in China related to green building materials across the areas of standardization, certification, and labeling

	13th FYP on Energy Saving and Environmental Protection Industry Development **“十三五”节能环保产业发展规划**	**MIIT Industry Green Development Plan (2016-2020)** **工业绿色发展规划（2016-2020年）**	**Guidance on establishing a uniform standardization, certification, and identification system for green products** **国务院办公厅关于建立统一的绿色产品标准、认证、标识体系的意见**	**13th FYP on Strategic Emerging Industries** **“十三五”国家战略性新兴产业发展规划**
Standardization	Improve the standardization system of green product and services, expand the coverage of the standardization, expedite the establishment and amendment of standards concerning the energy, water, and material consumption during the manufacturing process, and standards concerning energy efficiency, water efficiency, and environmental label during the whole life cycle of the end-product.	Emphasis should be put on phasing out outdated production facilities and dissolving overcapacity, especially in steel, petrochemical, building material, nonferrous metals industry, by actively applying environmental protection, energy consumption, technical, quality, security standards.	Draft standardization framework and detailed statements for green products using top-down design and systematic planning and build a uniform green products standardization system led by green products evaluation standards and supported by green products industrial supporting standards by taking advantage of the functionality of authoritative departments in major industries.	Strengthen the integration of green building material standards and energy saving codes for public building

	Establish and improve the energy saving and environmental protection standardization system, expedite the drafting and amending process of a set of mandatory energy efficiency, energy consumption cap, and pollutants emission standard, improve the technical requirement concerning energy saving and environment protection in product standards, and strengthen the coordination with national, local, sectoral, and company standards on energy saving and environment protection.	Draft standards and guidelines for the construction of green plants, and launch pilot demonstration programs in key industries like steel, nonferrous, petrochemical, building materials, automobile, textile, medical, electronic information, and light industries.		Improve the standards of environmentally-friendly products.
Certification & Labeling	Establish a uniform certification and identification system for green products, integrate existing environmentally friendly, energy saving, water saving, recyclable, low-carbon, renewable, and organic products into the green product, and strengthen the whole life cycle measurement and testing, quality examination, supervision, and regulation of green products. We will encourage certification institutions to provide a guarantee and bear joint liability for accredited green products.	N/A	Establish a set of uniform green products certification and identification system conforming to national conditions referencing international practices and publish regulations on the certification and labeling process.	Improve the energy efficiency labeling system and energy-saving product certification system, carry out energy efficiency leader mechanism in industry, building, transportation, and consumer goods fields, and promote leapfrog increase of energy efficiency of manufacturers.
URL	http://hzs.ndrc.gov.cn/newzwxx/201612/t20161226_832641.html?from=timeline&isappinstalled=0&nsukey=4ThyxnELF1qV1CzZ28OH84EribT6ZCte6isfI8rrMZgrfDJNFp3%2FMMlY3VmOQdsOkv4iY7pmbdEcE5TwPyn1enBd4aCzZOe8ghWQd3nJ63QHLP0cD6GDHu%2FGkkLjL10xLH6xEC4lS7gZy6okZU8h1gNhmHkf%2BYMNO8x1uvvKqPJWrLwHmT5XQqGYkIr7R7Jt	http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757016/c5143553/content.html	http://www.gov.cn/zhengce/content/2016-12/07/content_5144554.htm	http://www.gov.cn/zhengce/content/2016-12/19/content_5150090.htm

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