



**Asia-Pacific
Economic Cooperation**

Review of APEC Green Building Project

FINAL REPORT

APEC Sub-Committee on Standards and Conformance

July 2016



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Economic Cooperation**



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REVIEW OF APEC GREEN BUILDING PROJECT

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U.S.-APEC Technical Assistance to Advance Regional
Integration (US-ATAARI)

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This publication was produced by Nathan Associates Inc. for review by the United States Agency for International Development.

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DISCLAIMER

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List of Abbreviations

APEC	Asia Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
ASTM	American Society for Testing and Materials
BIM	Building Information Modeling
IAPMO	International Association of Plumbing and Mechanical Officials
NAMAS	Nationally Appropriate Mitigation Actions
NIST	National Institute of Standards and Technology
SCSC	Sub-Committee on Standards and Conformance
US-ATAARI	United States-APEC Technical Assistance to Advance Regional Integration

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EXECUTIVE SUMMARY

OVERVIEW

The Asia-Pacific Economic Cooperation (APEC) project entitled *The Role of Standards and Conformity Assessment Measures in Enhancing the Performance and Energy Efficiency of the Commercial Building Sector* (MCTI 02 12A; referred to as the “Green Building Project”) was spearheaded by the United States Department of Commerce/International Trade Administration, in close partnership with Australia, Brunei Darussalam, Canada, Indonesia, Japan, Korea, New Zealand, Papua New Guinea, Peru, Singapore, and Chinese Taipei. Over a three year period, the United States worked with key partners to increase international collaboration around standards and codes for sustainable construction in the Asia Pacific region. The Project builds on work to-date carried out by APEC member economies to advance green building and building energy efficiency and was implemented through the APEC Sub-Committee on Standards and Conformance (SCSC). All of the activities under the multi-year project received support from the United States Agency for International Development (USAID) project, the US–Asia-Pacific Economic Cooperation (APEC) Technical Assistance to Advance Regional Integration (US-ATAARI). The Project was approved for APEC funding in 2012 and operated through 2015.

Project activities specifically promoted an understanding of how green building codes and building information modeling (BIM) can advance the goals of sustainable construction. Through the Project, four publications and a series of four workshops were developed and delivered. Two workshops and two publications focused on building codes and green building, and two workshops and two publications covered BIM. The publications were disseminated among APEC green building stakeholders and have collectively received over 20,000 downloads¹ from the APEC website. The workshops convened over 350 stakeholders from APEC member economies as well as interested parties from the Association of Southeast Asian Nations (ASEAN), and international standards development organizations.

Workshop Name	Description
March 2013, Lima, Peru, Sharing Experiences in the Design and Implementation of Green Building Codes	216 participants (including 182 from Peru) spanning 14 economies (including two non-APEC member economies—Lao PDR and Burma) attended this workshop on sharing best practices for developing and implementing green building codes. Presenters at this workshop were primarily from standards development organizations based in North America. Presenters represented six APEC member economies (Canada, China, Chinese Taipei, Indonesia, Peru, and the U.S.).

¹ Data represent number of downloads, as shown on publications.apec.org, as of March 20, 2016.

<p>June 2013, Medan, Indonesia, How Building Information Modeling Standards Can Increase Building Performance</p>	<p>58 participants spanning 18 economies (including 1 non-APEC member economy, Cambodia) attended this workshop. Presenters introduced attendees to BIM standards and represented nine APEC member economies (Australia, China, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore and the U.S.).</p>
<p>August 2014, Beijing, China, Utilizing Building Information Modeling to Increase Building Performance</p>	<p>48 participants spanning 18 economies (including one non-APEC member economy, Cambodia) attended this workshop. Presenters represented six APEC member economies (Australia, China, Hong Kong, Russia, Singapore, and the U.S.) and focused on BIM's potential to impact building energy efficiency.</p>
<p>October 2014, New Orleans, United States, Utilizing Green Building Codes to Increase Building Performance</p>	<p>38 participants spanning 14 economies (including two non-APEC member economies—Cambodia and Lao PDR) attended this workshop, which featured speakers representing standards development organizations such as the ASTM International and the International Association of Plumbing and Mechanical Officials (IAPMO) Group. Presenters represented five economies (Chile, China, Indonesia, Mexico, and the U.S.).</p>
Resource Name	Summary
<p>APEC Green Building Code Infrastructure Guide – May 2015 Download available at: http://publications.apec.org/publication-detail.php?pub_id=1623</p>	<p>This short guide proposes a flexible framework to advance code requirements while leveraging the strengths and accommodating the realities of individual economies. The guide provides details on the components necessary to support effective green building code policy development, implementation, enforcement and evolution and helps stakeholders identify and close gaps in local code infrastructure.</p>
<p>Start-Up Guide, Building Information Modeling – February 2014 Download available at: http://publications.apec.org/publication-detail.php?pub_id=1510</p>	<p>This two-page resource outlined the progression from minimal BIM adoption to developing innovative BIM capabilities. The resource helps economies identify where they are on the BIM adoption timeline and the specific actions they can take at each stage to advance BIM implementation as well as the associated benefits.</p>
<p>APEC Guide to Performance Metrics and BIM to support Green Building Objectives – June 2015</p>	<p>This resource builds on the BIM Start-Up Guide (above) with special emphasis on the value of BIM to improve green building outcomes. It supports the standardization and</p>

<p>Download available at: http://publications.apec.org/publication-detail.php?pub_id=1632</p>	<p>measurement of green building accomplishments and provides further guidance for selection and development of policies, programs, standards, technologies, and tracking mechanisms specific to support green building initiatives which could include reductions in CO₂, water use, energy use, etc.</p>
<p><i>Building Codes and Standards: Minimum, Mandatory and Green – August 2013</i> Download available at: http://publications.apec.org/publication-detail.php?pub_id=1442</p>	<p>This resource details how individual APEC member economies have utilized building codes to increase building performance. This publication provides economy-specific chapters, verified by representatives of each economy. Key findings and recommendations across the region are also included.</p>

EVALUATION DESIGN, DATA COLLECTION, AND ANALYSIS

The four workshops and subject-specific publications developed during this project highlighted best practices in building code development, implementation, enforcement, and evolution, and promoted BIM as a means of improving building performance. The overall goals of this project were to 1) encourage consistent, transparent, and appropriate green building standards-related measures that avoid creating unnecessary obstacles to trade, 2) identify best practices in standards and code development which would be beneficial to APEC members that are considering policies and initiatives to facilitate green building, and 3) build communications among the many stakeholders that play a role in greening the commercial building sector in the Asia-Pacific region to advance collaboration and improve the effectiveness of green building code implementation. This report reviews information collected to evaluate whether these objectives were met through the Project.

Data collection was primarily comprised of an online survey (see Annex I) which was distributed to workshop attendees as well as other interested parties that may have utilized the published resources. Feedback was provided by 28 respondents ²(12 percent of survey recipients). Further insight was collected through direct interviews with key stakeholders and survey respondents on how the resources were or were not useful, as well as how workshop attendees leveraged the information they learned through the Project to promote green building in their respective economies.

FINDINGS AND CONCLUSIONS

The Project effectively reached its target audience with best practices for green building.

Activities under the Green Building Project reached every APEC member economy as shown through workshop attendance. The number of online publication downloads also indicates significant use of these resources.

² Not all respondents answered all the questions. Some questions were either not relevant to certain respondents, or the respondent chose to skip questions for unknown reasons.

The Project addressed the needs of APEC member economies in advancing green building.

When asked to identify best practices developed through the Project which they found useful to advancing green building, survey participants responded positively to several best practices including (1) the development of policies that promote efficient products, and (2) practices to update and strengthen measures in existing green building codes.

The Project supported a variety of actions within individual economies.

Participants reported positively to taking action on green building, supported by the resources developed through the Green Building Project. Actions included (1) increasing the use of international standards; (2) establishing or expanding stakeholder processes; (3) promoting the incorporation of local market assessments of materials, products, and technology; and (4) supporting policy development.

The Project demonstrated the value of public-private collaboration.

The collaboration between public and private sector organizations was evident in the workshops and resource development processes—demonstrating the opportunity and productivity that can be gained from such partnerships.

Continued support is needed.

All economies have opportunities for improvement and need resources, as evident by the many activities underway and the specific requests from economies for continued support.

I. INTRODUCTION

The free flow of green building materials and technologies is closely linked to a shared foundation for standards and conformity assessment across economies. When building codes enable the most efficient products and technologies to be applied, and these materials are easily available in local markets, codes can improve the energy efficiency and environmental impact of buildings, leading to significant advances for economies in areas related to green growth. The United States led implementation of a three year project to increase international collaboration around standards and codes for sustainable construction in the Asia-Pacific Economic Cooperation (APEC) region. All of the activities under this multi-year project received support from the United States Agency for International Development (USAID), and the US–APEC Technical Assistance to Advance Regional Integration (US-ATAARI). The U.S. Department of Commerce/International Trade Administration served as project overseer. The resulting APEC multiyear Green Building Project was developed to increase capacity to achieve energy and resource savings in commercial buildings, and to promote consistent, transparent, and appropriate adoption of green building measures.

This report evaluates the Green Building Project against its three main objectives, as described in the Statement of Work, using three corresponding questions:

Objective 1: Encourage consistent, transparent and appropriate green building standards-related measures, and thus avoid creating unnecessary obstacles to trade.

- Did code development activities expand to include more stakeholder involvement and result in higher adoption rates of international standards?

Objective 2: Identify best practices in standards and code development ... which would be particularly beneficial to APEC members that are now considering policies and initiatives to facilitate green building, and would result in a cleaner, more energy efficient commercial building sector.

- Did the best practices we identified support policies and initiatives for greener buildings?

Objective 3: Build communications among the many stakeholders that play a role in greening the commercial building sector in the Asia Pacific region to advance collaboration and improve the effectiveness of building standards/code implementation.

- Did the workshops provide beneficial interaction between participants to support collaboration and effective progress?

This report reflects a review and stock-taking of the achievements and impacts of this project. The remainder of the report is organized as follows:

- Chapter II provides an overview of the Green Building Project;
- Chapter III describes the evaluation methods and limitations; and
- Chapter IV presents the findings and conclusions.

II. PROJECT BACKGROUND

The Green Building Project builds on years of work driven by APEC to promote energy efficiency and high performing buildings. The APEC Sub-committee on Standards and Conformance (SCSC), established in 1994, specifically seeks to address the negative impacts of different standards and conformance arrangements in use among its member economies. The Project Team collaborated with the SCSC to implement activities that promote best practices in the development, implementation, enforcement, and evolution of green building codes and building information modeling (BIM). These activities produced a series of four workshops and the development of four publications. The workshops convened over 350 stakeholders from APEC member economies as well as interested parties from the Association of Southeast Asian Nations (ASEAN) and international standards development organizations. The publications were developed and also disseminated among these green building stakeholders. Two of the workshops and two guide publications focused on building codes, and the other two workshops and two guides pertained to BIM. Each of the four publications was made available for free download from the APEC website.

In leading this project, the U.S. worked closely with a number of individuals and organizations from the public and private sectors involved in advancing green buildings through codes and standards, and technology in the U.S. and around the world. In addition, a U.S. Advisory Group contributed to project development and implementation, and included 36 private sector organizations and four U.S. government agencies. (See Appendix II for a full listing of members.)

The main objectives of the Green Building Project were to 1) encourage consistent, transparent, and appropriate green building standards-related measures that avoid creating unnecessary obstacles to trade; 2) identify best practices in standards and code development which would be beneficial to APEC members that are considering policies and initiatives to facilitate green building; and 3) build communications among the many stakeholders that play a role in greening the commercial building sector in the Asia-Pacific region to advance collaboration and improve the effectiveness of green building code implementation. A brief summary of the workshops and publications developed to meet these objectives is included below.

GREEN BUILDING CODES

Sharing Experiences in the Design and Implementation of Green Building Codes – Lima, Peru (March 2013)

The first activity under the Green Building Project was a workshop in Lima focused on green building codes. It had 216 attendees from 14 different economies, including approximately 182 attendees from the host economy of Peru, and attendees from Lao PDR and Burma. The two and a half-day agenda included nine sessions and covered broad introductory topics, as well as the experiences of individual economies. Session speakers represented a number of standards development organizations and code development organizations, including National Institute of Standards and Technology (NIST), ASTM

International, Underwriters Laboratories, and the International Code Council. The economies of Canada, China, Chinese Taipei, Indonesia, Peru, and the United States were also represented by speakers.

APEC Building Codes, Regulations, and Standards – Minimum, Mandatory and Green (August 2013)

Following the Lima workshop, this study updated information on how individual APEC member economies develop, adopt, and enforce building codes—describing the foundation for establishing best practices and consistent standards. The key findings showed that multiple pathways are being utilized to support green building code development, and successful strategies align with each economy’s approach to regulation and engagement of non-government organizations. The study also demonstrated that the APEC region saw existing commonalities in areas targeted for improvement through building codes—energy and water efficiency, indoor air quality, light pollution, land use, environmental protection, and storm water management. The study determined that existing international reference standards could be utilized in support of the various code development approaches in use, as well as international standards for building materials and technology.

Utilizing Green Building Codes to Increase Building Performance – New Orleans, U.S. (October 2014)

This two and a half-day workshop had 38 attendees from 14 different economies, including Cambodia and Lao PDR. The agenda focused on best practices and experiences in various economies in working with international standards including China, Chile, Indonesia, Chinese Taipei, and Mexico. Several speakers represented prominent standards development organizations such as ASTM International and the International Association of Plumbing and Mechanical Officials (IAPMO) Group. A working session was included to review and discuss the framework presented in the Green Building Code Infrastructure Guide (see below).

APEC Green Building Code Infrastructure Guide – Framework Document (May 2015)

In support of promoting best practices among APEC economies, this guide was developed to provide a common framework for code development and implementation. The proposed approach recognizes that specific goals and drivers will vary, and market conditions and climate will further fluctuate between economies; nevertheless, there are key activities that can be broadly applied to identify gaps and strengthen green building codes. The guide includes examples of how APEC economies are achieving success through these activities to advance codes and provides (1) a checklist to be used in identifying gaps, (2) recommendations on where to start, and (3) best practices from other economies to use as models.

BUILDING INFORMATION MODELING (BIM)

How Building Information Modeling Standards Can Increase Building Performance – Medan, Indonesia (June 2013)

The BIM project activity was kicked off by a two-day workshop which introduced the concept of building information modeling and its value for green building. Experiences in the U.S., China, Malaysia, Singapore, Australia, Korea, Indonesia, and the Philippines were provided by speakers. The workshop concluded with a session on specific recommendations to advance BIM, following a discussion on ways in which wider use of BIM could be encouraged in green building. The workshop had 58 attendees representing 18 economies, including Cambodia.

Start-Up Guide, Building Information Modeling (February 2014)

This guide was developed to help economies in identifying actions they can take to advance BIM, based on their current status of activity and policy. The guide provides specific recommendations for action related to (1) tracking impact and progress, (2) establishing objectives and protocols, (3) finding the right people and processes, and (4) providing the right tools. Benefits for each action are also included to support understanding of the value of BIM.

Utilizing Building Information Modeling to Increase Building Performance – Beijing, China (August 2014)

This two-day workshop had 48 attendees representing 18 economies, including Cambodia. The agenda focused on increasing momentum for the use of BIM and included presentations of case studies from Australia, China, Hong Kong, Russia, Singapore, and the United States.

APEC Guide to Performance Metrics and BIM to support Green Building Objectives (June 2015)

This guide presents an overview of green building and BIM programs in order to emphasize a number of key objectives which support increased adoption of BIM practices, including alignment of strategic objectives among policies, standards, and technologies. The guide walks users through establishing objectives and success metrics, developing policies, and creating standards, rating systems, and guidelines. The guide also covers various applications of BIM and metrics/key performance indicators, and elements of a successful education program.

III. EVALUATION METHODS AND LIMITATIONS

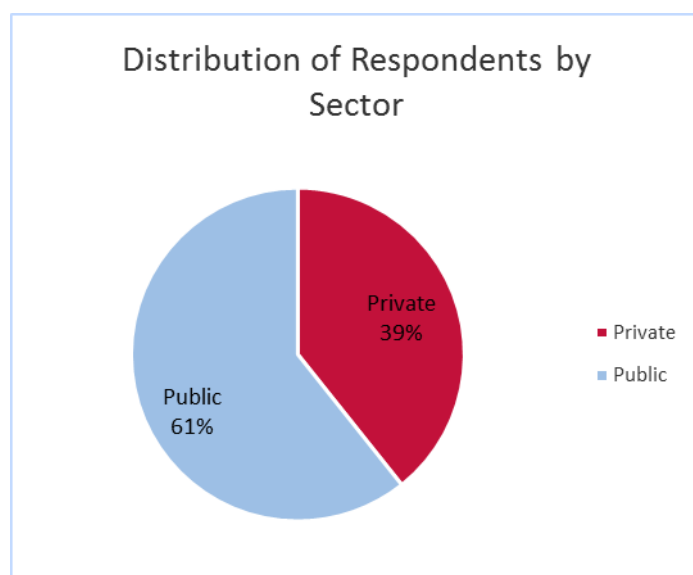
DATA COLLECTION METHODS

The Evaluation Team collected information for this assessment through the following means:

- **Document review** – The team reviewed workshop attendance history to collect available data points such as number of training beneficiaries, website traffic, and electronic file downloads; this also included a review of workshop speakers and presentation topics.

- **Survey** – An online survey (using a questionnaire containing both open- and close-ended questions) was developed and distributed to approximately 330 members of the APEC network who attended the workshops, as well as ASEAN workshop attendees from Cambodia and Lao PDR. The questionnaire was additionally distributed to others who were involved in reviewing the publications and contributing to the design of the Green Building Project. Of these, 28 respondents (approximately 12 percent) submitted completed surveys. (See Annex I for the complete questionnaire). During the initial review of the online survey results, one survey respondent was removed from the evaluation due to submitting an incomplete. Participants in the online survey were slightly weighted toward the public sector, with respondents representing 59 percent, and those from the private sector representing 41 percent (see Figure 1). The online survey respondents represented 10 of the 21 APEC member economies, as shown in Figure 2, as well as two additional interested economies from ASEAN—Lao PDR and Cambodia.

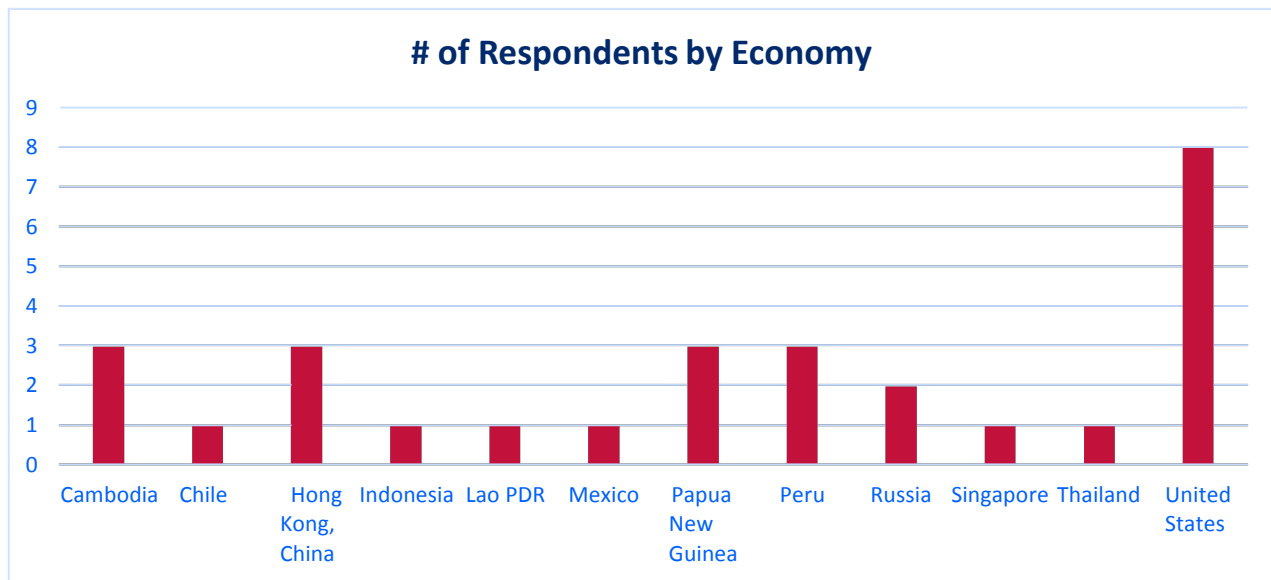
Figure 1 Online Survey Respondents by Sector



Source: Online Survey. N= 28

- **Direct informant interviews and follow-up** – Telephone interviews and direct email communication were used to gather additional information on the value and impact of the project activities. Based on the survey responses, the Evaluation Team conducted follow-on outreach to select respondents who reported policies and/or practices had changed within their organization as a result of attending one or more of the workshops on building efficiency or BIM. (This data was examined separately and not added to the survey result summaries.)

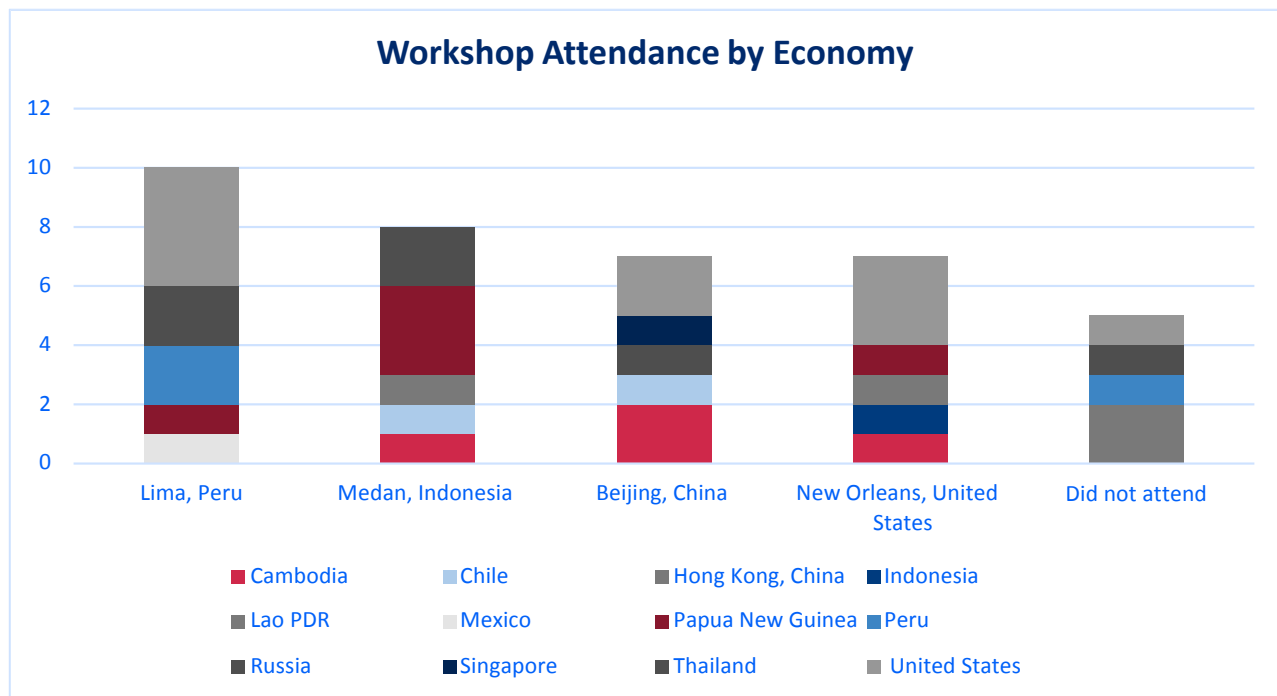
Figure 2 Online Survey Respondents by Economy



Source: Online Survey. N= 28

The profile of online survey respondents and their respective economies, shown above in Figure 2, is representative of the economy representation across all workshop attendees (see Figure 3), with one exception. Peru was an active co-sponsor and host for the March 2013 kickoff workshop held in Lima, and had 177 representatives from Peru attending—far more than from any other economy at any of the

Figure 3 Workshop Attendance by Economy (Survey only)



Source: Online Survey. N= 28

other three workshops.

DATA ANALYSIS

In analyzing the online survey results, an analysis of the following questions was used to identify the specific ways in which respondents found the resources and/or workshops to be relevant to their interests, as well as effective in inspiring further action in the respondents' respective economies and organizations:

- Which of the resources did each respondent use, if any, and how they were applied?
- Did stakeholders who attended either of the workshops on green building codes also use the green building code resources? (The same assessment was conducted for the two BIM workshops and BIM resource use.)
- Did the stakeholders who used the green building code resources or attended the green building workshops report changes in practices at their respective ministries/organizations? (The same assessment was conducted for BIM resource use and workshop attendance.)
- By economy, in which ways are respondents applying the green building codes and BIM work?
- By economy, which best practices identified during the Project has been, or will be applied, in the respective economy to advance green building?
- By economy, how have policies or practices changed at a respondent's organization as a result of the building codes and/or BIM work?

LIMITATIONS

The Evaluation Team is confident that the response rate for the workshop attendees, as well as the representative economy profile of respondents, is sufficient to draw general conclusions regarding the achievement of project goals. However, certain limitations on the data should be considered, including the following:

- Given the small sample size, the responses cannot necessarily be considered representative of the APEC member network as a whole.
- There may be some level of self-selection bias among respondents (i.e. those who found the trainings more or less useful than average may have felt more compelled to participate in the survey).

IV. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

PROGRESS AND ACHIEVEMENT ON MEETING PROJECT GOALS

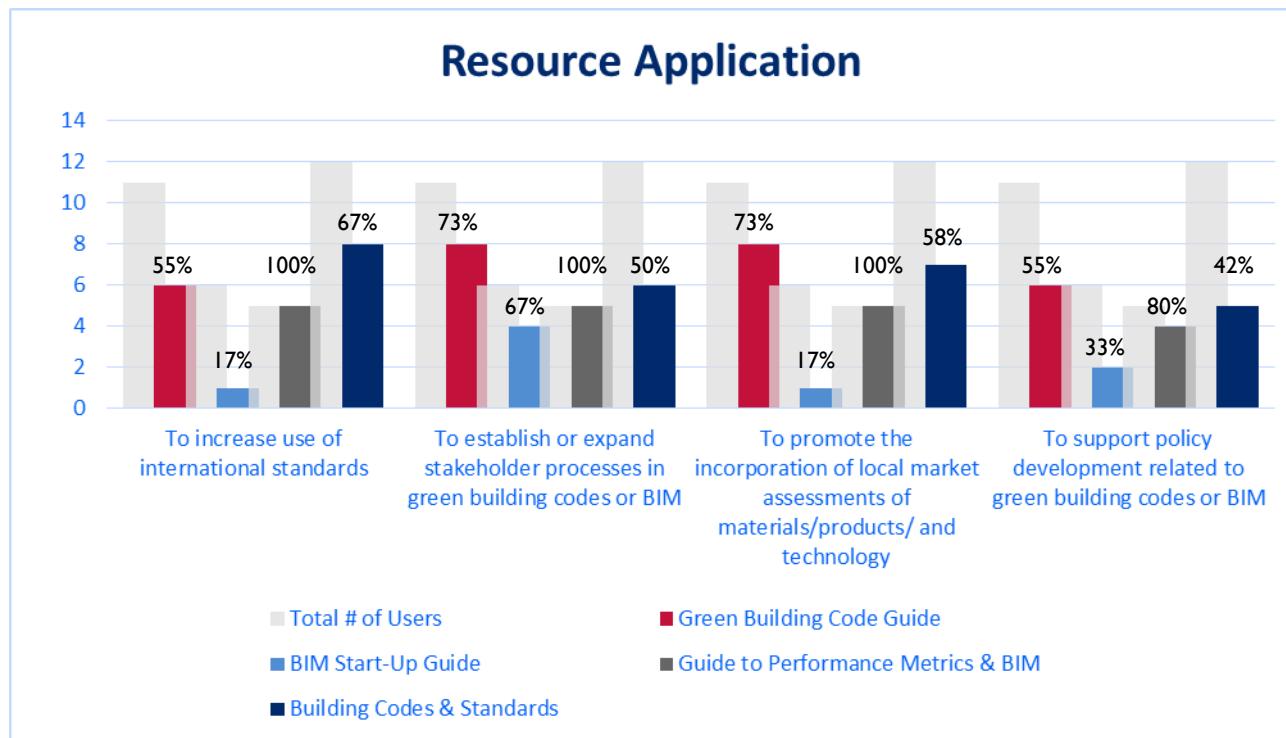
This section presents overall findings for the Green Building Project review. The study collected information on the types of actions that took place in economies as a result of project activities. The data highlights how information gained from attending the workshops and use of the publications led to changes within the respondents' home economies. In cases where survey respondents indicated government or organization policy and/or practices had changed as a result of the project's work on green building codes and BIM, additional detail was requested through phone or email communication. The findings are discussed below by each of the three Green Building Project objectives, followed by a section on cross-cutting findings and conclusions.

Encourage consistent, transparent, and appropriate green building standards-related measures that avoid creating unnecessary obstacles to trade.

To assess the degree to which the Green Building Project led to economy-level actions or information-sharing, the online survey asked respondents about (1) how they used the resources and/or the information learned through the workshops; (2) the specific actions they took after attending a workshop where they heard presentations, interacted with their peers, and learned about supporting resources; and (3) about specific ways in which they are applying both the green building code and BIM work in their economies.

Figure 4 shows how respondents applied publications developed under the Project relative to the total number of respondents who reported using that resource. The responses suggest that some resources were better suited to specific objectives.

Figure 4 Resource Application



Source: Online Survey. N= 21

For green building code resources:

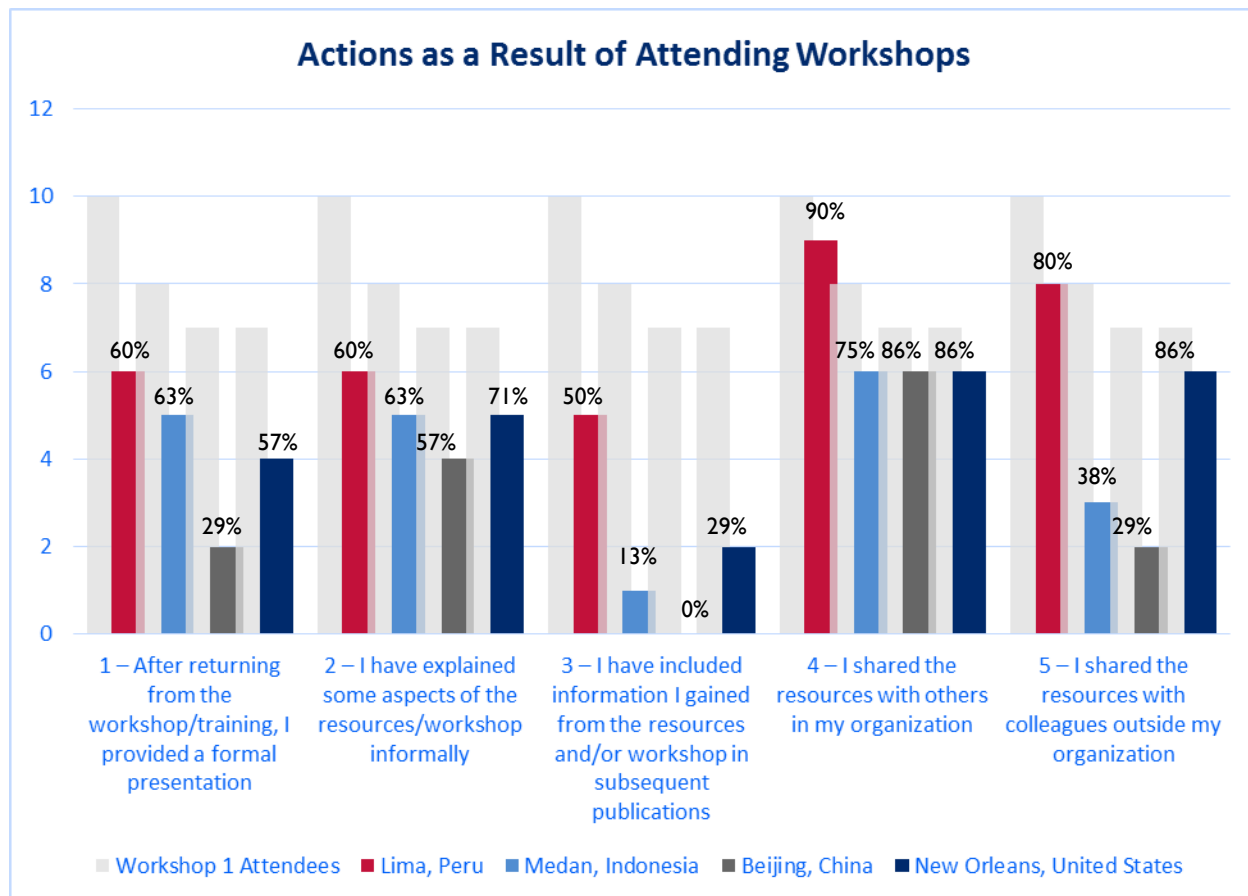
- The **Green Building Code Guide** (red) was MOSTLY used to establish or expand stakeholder processes and promote the incorporation of local market assessments of materials, products, and technology. Half of the respondents who used this resource also reported that it was relevant to activities to increase the use of international standards and support policy development.
- The **Building Codes and Standards** publication (dark blue) was MOSTLY used to increase the use of international standards. Approximately half the users also applied this resource in establishing or expanding stakeholder processes in green building codes, promoting the incorporation of local market assessments of materials, products, and technology, and supporting policy development related to green building codes.

For the BIM resources:

- Of the respondents who used the **BIM Start-Up Guide** (light blue), the data suggests that this resource was MOSTLY used to establish or expand stakeholder processes in BIM. Roughly one third of users also reported using this resource to support policy development.
- All respondents who used the **Guide to Performance Metrics and BIM** (gray) applied it to increasing the use of international standards, establishing or expanding stakeholder processes in BIM, and promoting the incorporation of local market assessments of materials, products, and

technology. This resource was also MOSTLY used to support policy development related to BIM, which was the intended use of the Guide.

Figure 5 Actions as a Result of Attending Workshops



Source: Online Survey. N= 22

All respondents reported some follow-on action taking place after participating in one of the workshops (see Figure 5). Actions included providing formal presentations within their organizations, informally discussing the resources or workshop information, including information gained from the resources and/or workshops in publications, and sharing the resources with colleagues within and outside the attendees' organizations. Across the board, the majority of workshop attendees reported disseminating information on the resources and workshops within their organizations. Relatively fewer attendees included information gained from the resources or workshops in subsequent publications. However, of those attendees who did report incorporating information gained from building code resources or the workshops into publications, far more of those respondents attended building codes workshops as compared to BIM workshops.

- At least half of the **Lima, Peru** building codes workshop attendees reported taking one or more of the actions outlined in the survey. The consistent positive response rate could be due to this

workshop taking place early in the Project, providing extended time for information gained at this workshop to be included in publications.

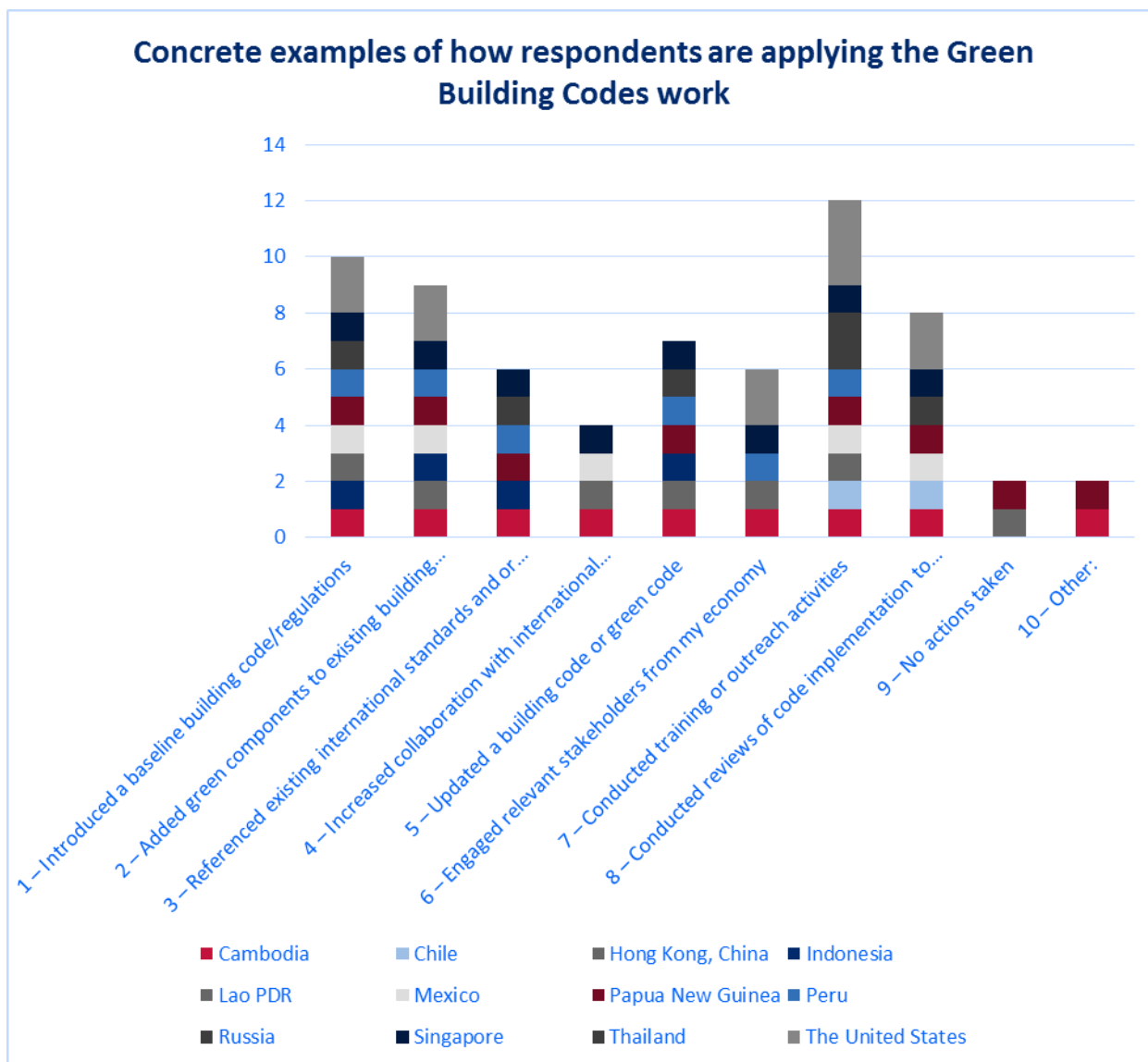
- **Medan, Indonesia** BIM workshop attendees reported SOME instances of presenting formal presentations, explaining aspects of the resources or workshops informally, or sharing the resources outside their organization. MOST attendees reported sharing the resources within their organizations. This suggests that the information was shared internally, but the respondents did not take strong efforts to apply the information externally via publications or to share externally.
- **Beijing, China** BIM workshop attendees similarly did not widely distribute the resources or information gained at the workshop with colleagues outside their organization, and NONE of the attendees included information gained at this workshop or from the BIM resources in subsequent publications. MOST attendees shared the resources within their organizations.
- More than half of the **New Orleans, United States** building codes workshop attendees reported providing a formal presentation following the workshop, explaining aspects of the Project informally, and sharing the resources internally and externally.

Action as a Result of Workshops

Example: Papua New Guinea

An attendee at the Lima, Peru green building codes workshop, representing a structural and civil engineering firm in Papua New Guinea, reported that he has continuously passed on information gained from that workshop. He has primarily shared information with local architects and builders in private practice and notes that there have been “considerable changes in the design practices of consultants trying to introduce as much as possible of the Green Building Codes into new works and designs.” Introducing green building strategies has had the most success when design or construction has been carried out through design or construction joint ventures with Australian and New Zealand companies. Although a few buildings have been constructed to include some green elements, the associated increased cost so far prevents buildings from fully integrating a green building strategy. One recent and popular change has been the introduction of shades/awnings to windows to save on cooling system power.

Figure 6 Examples of Green Building Code Activities



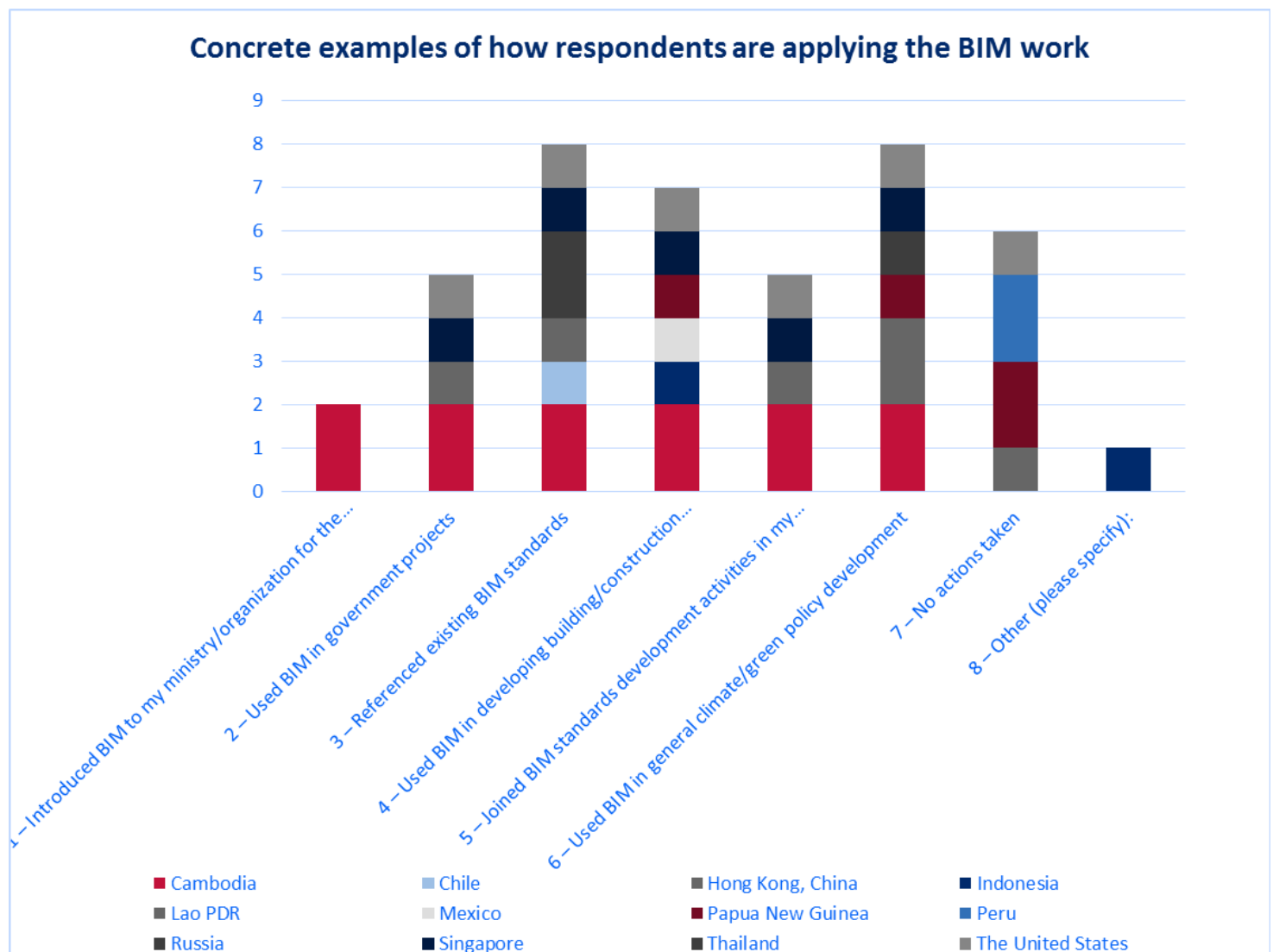
Source: Online Survey. N= 19

Survey respondents reported a number of ways that they are applying the green building codes and BIM work. Of the 19 respondents who provided feedback on examples of how their organizations are applying the green building codes work (see Figure 6), the highest number of respondents (over 60 percent) reported that they conducted trainings or other outreach activities. This took place in nine economies including Chile, Hong Kong, Mexico, Peru, and Russia. One respondent specifically reported

leading a presentation on green building at the inaugural Papua New Guinea Buildings Summit in 2014. The same number of economies, and over half of the respondents, reported introducing a baseline building code or regulation.

Additional actions that were strong across a large number of economies included adding green components to existing building codes/regulations, referencing existing international standards and/or codes, updating a building or green code, and conducting a review of code implementation to identify issues. These responses show that actions are taking place across a large number of economies to develop and strengthen green building codes and standards. The significant amount of training and outreach by participants will also compound the direct impacts of the workshops, and increase collaboration. In addition, the reported activity around referencing international codes and standards will

Figure 7 Examples of BIM Activities



Source: Online Survey. N= 19

further lead to uniformity and/or harmony between the different regulations and practices among economies over time.

Among respondents reporting on actions their organizations have taken to apply the BIM work (see Figure 7), the largest number of economies reported using the Project's BIM-related activity to reference existing BIM standards. The same number reported applying BIM for general climate/green policy development. Also, a relatively large number of economies are using BIM in developing building/construction policies/regulation. Notably, the respondents from Cambodia responded positively to ALL actions for applying BIM, including the introduction of BIM to their ministry/organization for the first time.

Applying Green Building Codes Work

Example: Peru

Input from a private sector participant in the Lima, Peru green building codes workshop, representing Energia Verde, a Peruvian consulting firm, provided details on a number of local activities taking place to advance green building codes that build off of the participation and technical documents from the workshop:

- May 2014 – The first green building regulation (EM.110: Thermal and Lighting Comfort with Energy Efficiency) enacted (Supreme Decree N° 006-2014-Vivienda) and now officially part of the National Building Regulation (currently voluntary).
- June 2014 – The Ministry of Housing, Construction and Sanitation (MHCS) delegates the function of developing sustainable building policy and regulation to the Construction Directorate (Supreme Decree N° 010-2014-Vivienda); sustainable building becomes part of state policy.
- October 2014 – The Permanent Committee on Sustainable Building is established, to be led by MHCS, with the responsibility for developing the Technical Code on Sustainable Building (TCSB).
- December 2014 – MHCS introduces the “NAMA on Sustainable Building with City View” concept note in Lima’s Conference of Parties (COP20).
- August 2015 – The TCSB is enacted and the Permanent Committee made official (Supreme Decree N° 015-2015-Vivienda).

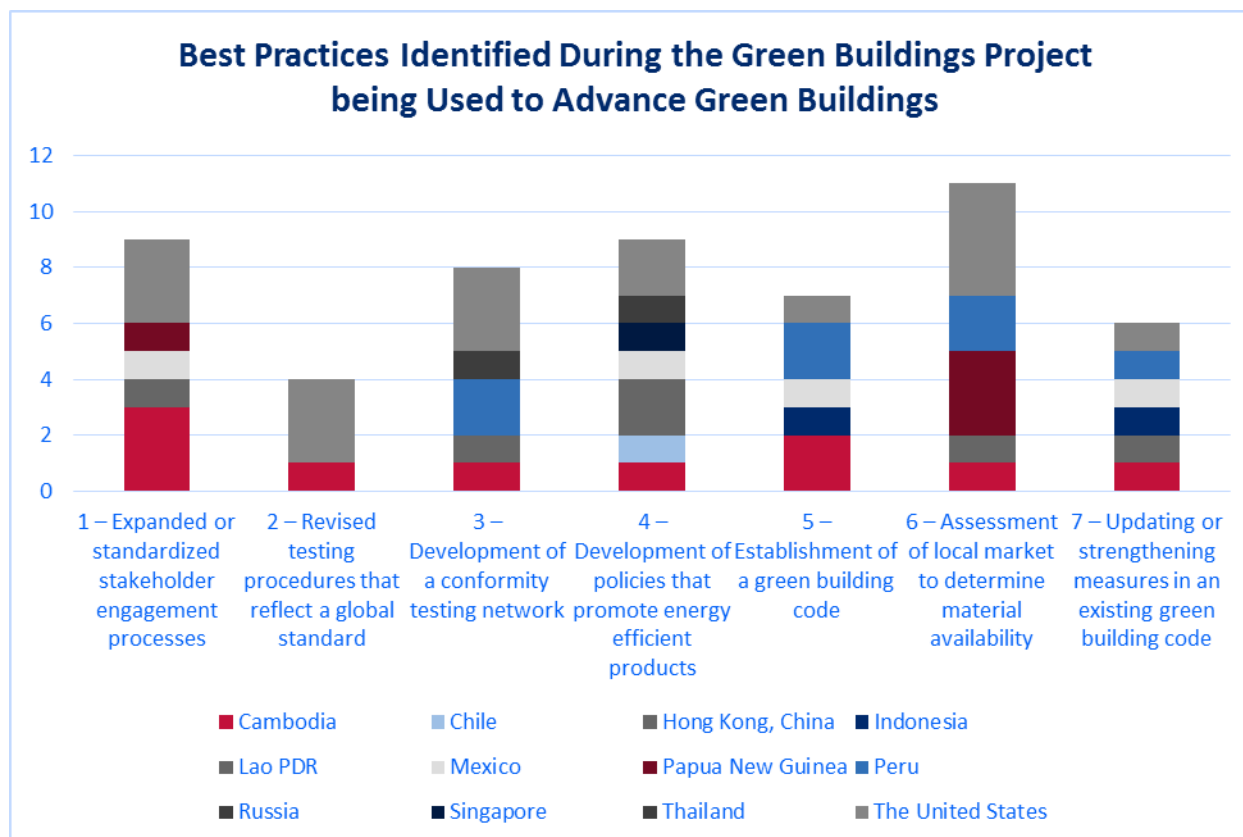
Identify best practices in standards and code development which would be beneficial to APEC members that are considering policies and initiatives to facilitate green building.

To examine if and how the resources and workshops were consistent with the overall goals and needs of the recipient organizations, the online survey asked recipients about (1) which best practices identified during the Green Building Project, through the publications and/or workshops, will their economy use to advance green building; (2) the main benefits of the project activity on green building codes and BIM; and (3) the relevance of the information provided in each of the workshop.

The Project identified a number of best practices which workshop participants and publication users reported using to advance green building in their economies (see Figure 8). Survey participants responded positively to using almost every best practice included in the survey question, indicating a high relationship between the best practices developed during the Project and the needs of the participating economies. Responses included using best practices on expanding or standardizing stakeholder engagement processes, developing a conformity testing network, establishing and/or strengthening a green building code, and assessing the local market for building material availability. Respondents among the largest number of economies found the development of policies that promote

efficient products to be the most valuable best practice that was identified. It is notable that the same best practices were found to be valuable by economies on both end of the spectrum—among those

Figure 8 Green Building Best Practices



Source: Online Survey. N= 26

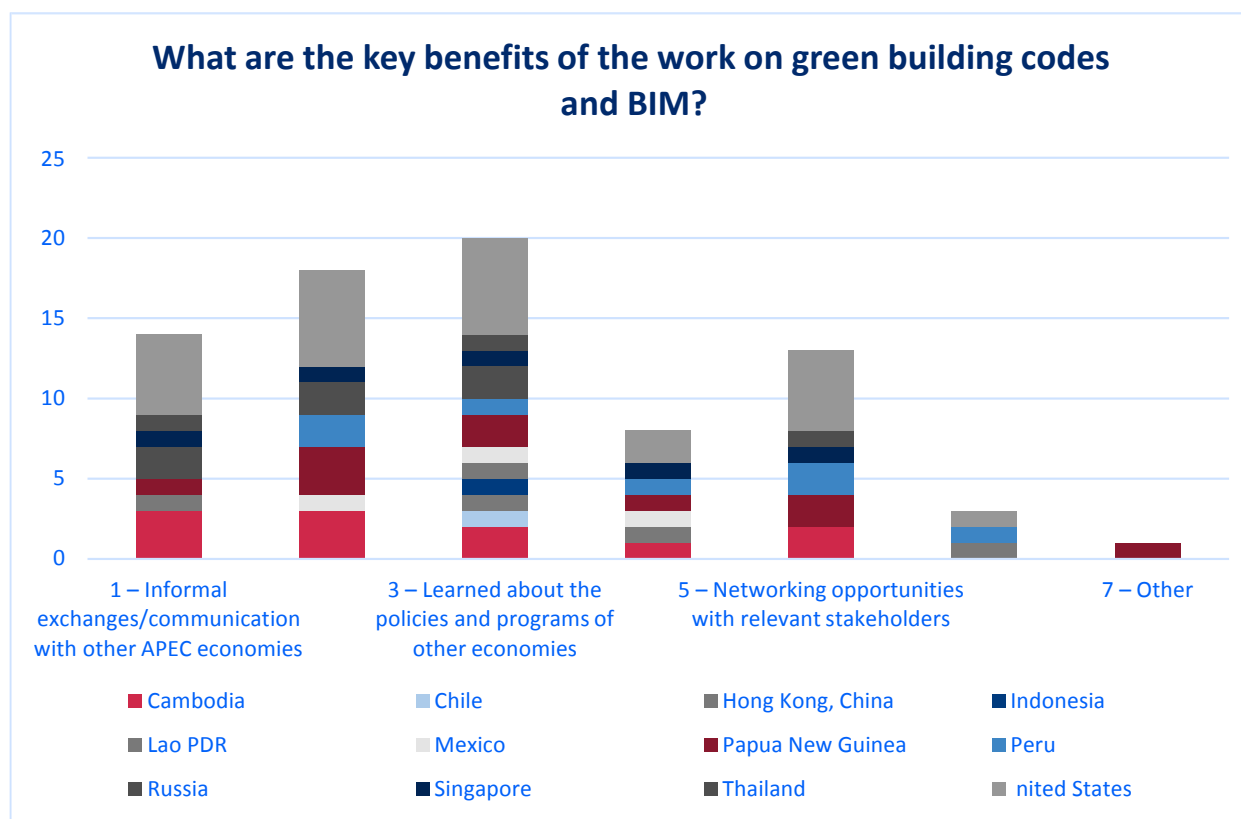
growing new markets for green buildings, as well as those where much progress has already been made.

Benefits of the Green Building Project

Example: Mexico

Involvement in the Green Building Project emphasized a key benefit to the participants from Mexico—the importance of harmonizing national and international standards. The Project provided resources and information to convince local stakeholders that there are valuable best practices outside of Mexico which can be helpful in developing national standards. Through working groups and the support of advisors from the United Kingdom, Germany, Denmark, and the United States, Mexico hopes to continue developing certification standards, financing, and other elements to advance green building.

Figure 9 Key Benefits to the Work on Green Building Codes and BIM

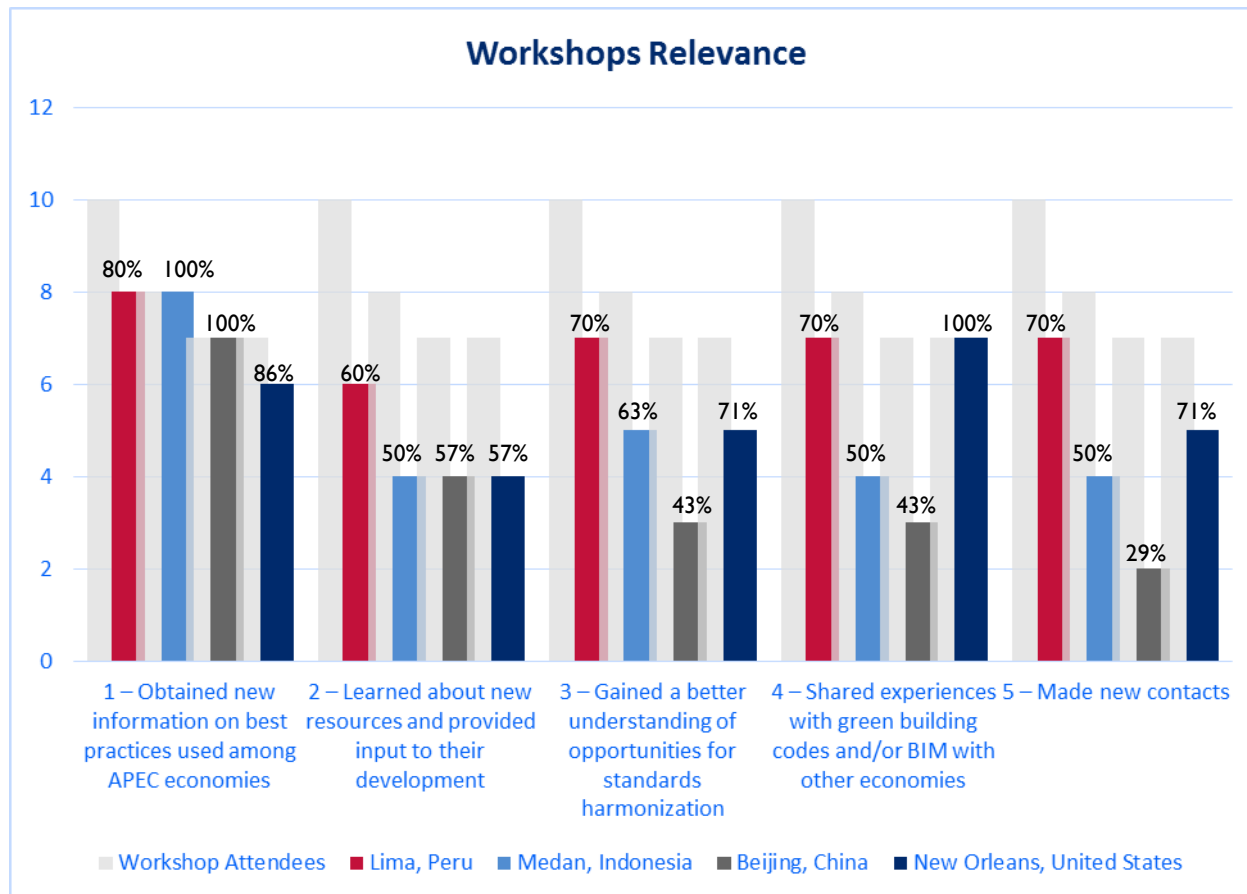


Source: Online Survey. N= 26

The online survey also collected stakeholder feedback on the key benefits perceived for the green building and BIM activity (see Figure 9). All participating economies reported that learning about the policies and programs of other economies was a key benefit of the Green Building Project. The other benefits proposed in the survey also all scored highly as key benefits—informal exchanges with other APEC economies, learning about existing relevant standards, contributing to the decision making on green building in economies, and networking with relevant stakeholders (i.e. standards development organizations, international donors, and intergovernmental organizations).

To further understand how the project activity was consistent with the overall goals and needs of the participating economies, the online survey collected stakeholder feedback on ways in which the workshop attendees found each of the four workshops to be relevant. Of the respondents, 23 attended at least one of the four workshops; their comments are summarized below (see Figure 10).

Figure 10 Workshop Relevance



Source: Online Survey. N= 23

- Lima, Peru** (Building Codes) workshop attendees MOSTLY reported obtaining new information on best practices with between 60-70 percent of attendees also reporting that they learned about new resources, gained a better understanding of opportunities for harmonization, shared experiences in developing green building codes, and made new contacts.
- Medan, Indonesia** (BIM) workshop attendees ALL reported obtaining new information on best practices. Roughly half of the attendees reported learning about new resources, gaining a better understanding of opportunities for harmonization, sharing experiences in developing BIM standards, and making new contacts.
- Beijing, China** (BIM) workshop attendees ALL reported obtaining new information on best practices. Approximately half of the participants reported learning about new resources and that they provided input into the development of these resources.
- New Orleans, USA** (Building Codes) workshop attendees ALL shared experiences developing green building codes with other economies. MOST of the workshop participants also reported that they obtained new information on best practices used among APEC economies. More than half of the survey respondents who attended this workshop also reported learning about new

resources, gaining a better understanding of opportunities for standards harmonization, and/or making new contacts.

When asked to provide specific details, a survey respondent who attended the workshops in Lima, Medan, and Beijing reported that she is using the information that she obtained in the workshops to develop educational programs. Another respondent, who represents a standards developing organization, and who attended the Lima and New Orleans building codes workshops, reported that she gained a better understanding of the codes and standards systems of other economies.

Standards Harmonization

Survey respondents attending the workshops in Lima, Peru and New Orleans, U.S. in particular, reported that they gained a better understanding of opportunities for using international standards. A number of APEC economies currently use ASTM International Standards in some way (either by consulting, referencing, or adopting them, or by using them as a basis for individual national standards). As of January 2015, these economies include Indonesia, which uses 440 ASTM standards, the Philippines, using 709 ASTM Standards, and Viet Nam, using 299 ASTM Standards. The top sectors represented by committees for use of these standards relate to fuels, paving materials, steel, concrete, etc. However, this level of use opens up the possibility in the future of expanding the types of standards to include those related more closely to green building.

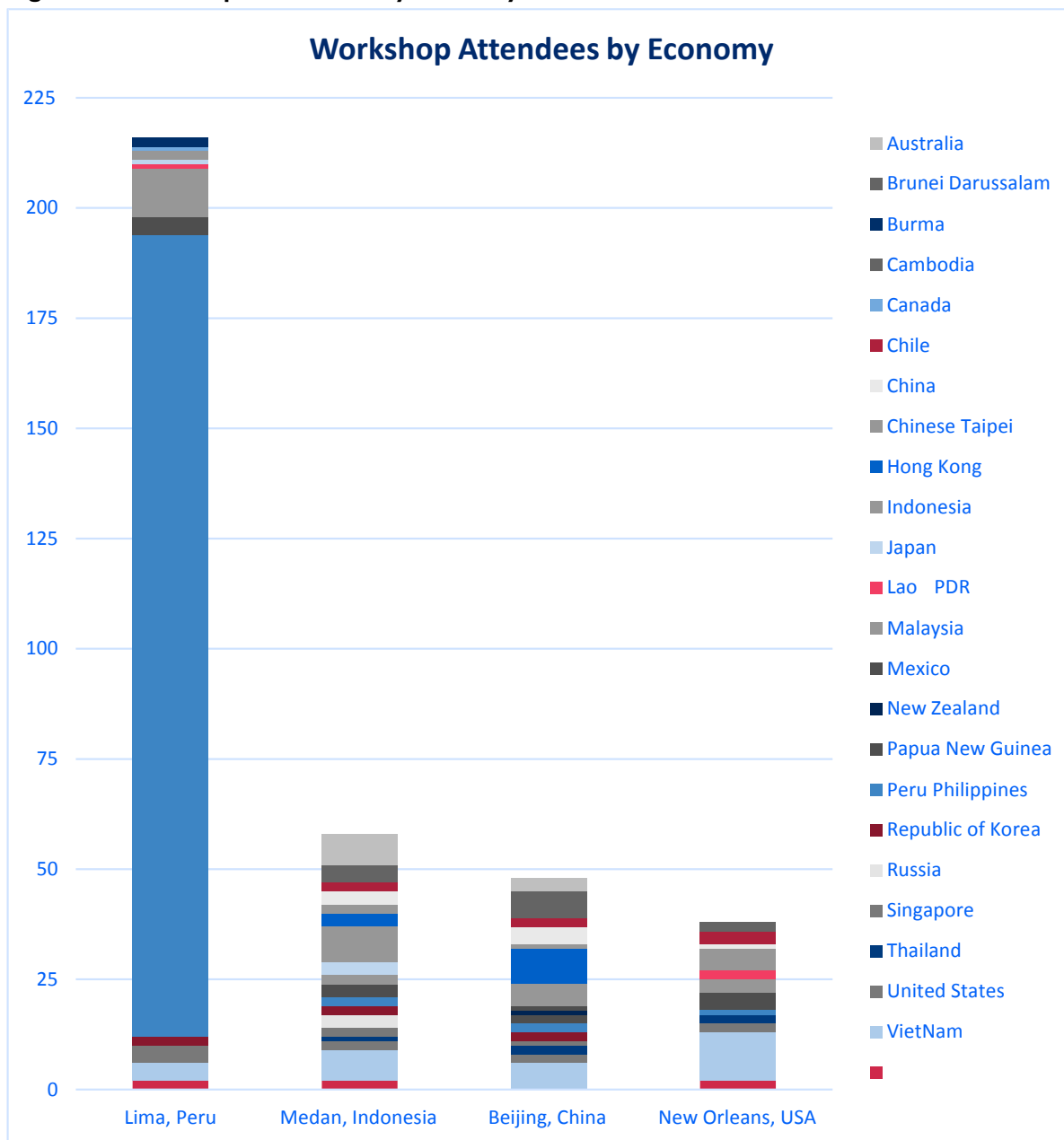
A key objective of the project was to build communications among the many stakeholders that play a role in greening the commercial building sector in the Asia-Pacific region in order to advance collaboration and improve the effectiveness of green building code implementation. Information on the extent to which project activities connected to stakeholders in each of the APEC member economies is derived from workshop attendance data and publication downloads. Although data on the number of downloads for each publication was not available by economy, the numbers do demonstrate a significant level of interest and access, as shown below.

Resource Name	# of Online Downloads from APEC Website ³
APEC Green Building Code Infrastructure Guide – May 2015	1267+
Start-Up Guide, Building Information Modeling – February 2014	8305+
APEC Guide to Performance Metrics and BIM to support Green Building Objectives – June 2015	1576+
Building Codes and Standards: Minimum, Mandatory and Green – August 2013	8512+

³ Data represent number of downloads, as shown on publications.apec.org, as of March 20, 2016.

The workshops delivered under the Green Building Project were highly successful in reaching APEC member economies—every APEC member was represented among the total group of workshop attendees. Through collaboration with ASEAN to support the early development of green building practices and policies, Cambodia, Lao PDR, and Burma also participated, as shown in Figure 11.

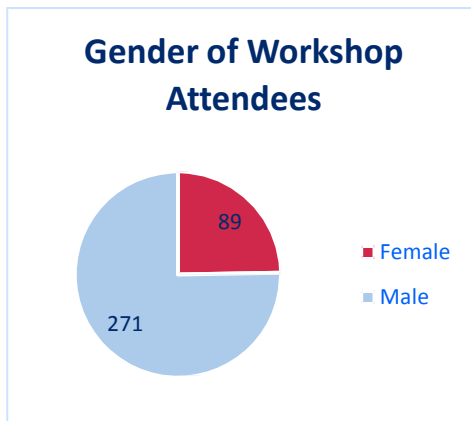
Figure 11 Workshop Attendance by Economy



Source: Workshop Attendees List, N=360

The gender distribution for workshop attendance is shown below in Figure 12. Among workshop presenters, the percentage of female speakers ranged from a high of 43 percent at the New Orleans, U.S. workshop focused on advancing green codes, to 15 percent at the Medan, Indonesia workshop on BIM Standards.

Figure 12 Workshop Attendees by Gender



Source: Workshop Attendees List, N=360

A. CROSS-CUTTING FINDINGS AND CONCLUSIONS

The following findings stand out across the Green Building Project activities:

The Project effectively reached its target audience with best practices for green building.

Overall, the Green Building Project was successful in reaching stakeholders within every APEC economy. The significant download numbers for the publications (over 20,000 across the four documents) and the workshop participation that represented every APEC member economy supports the finding that activities were well-positioned to provide broad impact. The study *Building Codes and Standards: Minimum, Mandatory and Green* (August 2013), details the extent to which APEC economies differ in their stage of green building code development. Nevertheless, economies at all stages reported benefits from their participation.

The Project addressed the needs of APEC member economies in advancing green building.

Respondents to the online survey reported value, or usefulness, for several best practices identified through the Project. These best practices included (1) the development of policies that promote efficient products, and (2) practices to update and strengthen measures in existing green building codes. The associated value of best practices did not correspond to economies growing new markets for green buildings, or those where much progress has already been made, indicating that economies are all facing many of the same challenges regardless of how advanced their green building markets may be.

The Project supported a variety of actions within individual economies.

Participants reported positively to taking action on green building, supported by the resources developed through the Green Building Project. Actions included (1) increasing the use of international standards; (2) establishing or expanding stakeholder processes; (3) promoting the incorporation of local market assessments of materials, products, and technology; and (4) supporting policy development.

All survey respondents who attended a workshop reported taking at least one follow-on action, including (1) providing formal presentations within their organizations, (2) informally discussing the resources or workshop information, (3) including information gained from the resources and/or workshops in publications, and (4) sharing the resources with colleagues within and outside the attendees' organizations. While the outcome of some of these actions may take several years to result in significant changes, this activity points to the success of the project activities in motivating and supporting economy representatives to advance codes and standards for green buildings.

The participant from Peru who detailed the activity taken since the Lima workshop, included information on how his consulting firm participated along with different government ministries in the work. Their work included technical support for the workshop, developing the first green building regulation, developing the concept note for the Nationally Appropriate Mitigation Action (NAMA) on sustainable building on behalf of the Peruvian Real Estate Developers Association (Adi Peru), serving as technical advisor to the Permanent Committee on Sustainable Buildings, and developing the proposal for the NAMA for subcomponent housing on behalf of the Inter-American Development Bank (ADB).

The Project demonstrated the value of public-private collaboration.

It is noteworthy that, although not a specific objective, the Project was very successful at demonstrating productive public-private collaboration and partnership. The U.S. is somewhat unique in its building code development process. Unlike many economies which have government-developed codes, the U.S. follows a private sector-led highly collaborative multi-stakeholder process with involvement from government at the federal, state, and local levels, as well as manufacturers, advocacy organizations, standard bodies, and others. While not necessarily a viable model for other economies, the process does foster input from significant numbers of professionals and experts. The cooperation between these various organizations was evident in the workshops and resource development processes. This aspect of the Project was identified during an interview by a member of the U.S. Advisory Group, and also highlighted by a participant and workshop speaker from Mexico.

Continued support is needed.

A Peru participant stressed that while he recognizes that this is a "transformational building experience," there is more work to do. He stated that support from APEC is desired to address the many challenging design and implementation tasks that remain. This sentiment was echoed by the representative from Papua New Guinea who suggested that while there is still a long way to go to fully adopt green building codes, it would be helpful if workshops and seminars were conducted, within the individual economies, to provide direct teaching among the relevant professions on economy-specific issues.

ANNEX I: SURVEY QUESTIONNAIRE

1. Have you used any of the following resources developed under this project? (please select all that apply)

- 1 – APEC Green Building Code Infrastructure Guide
http://publications.apec.org/publication-detail.php?pub_id=1623
- 2 – Start-Up Guide, Building Information Modeling
http://publications.apec.org/publication-detail.php?pub_id=1510
- 3 – APEC Guide to Performance Metrics and BIM to support Green Building Objectives
http://publications.apec.org/publication-detail.php?pub_id=1632
- 4 – Building Codes and Standards: Minimum, Mandatory and Green
http://publications.apec.org/publication-detail.php?pub_id=1442
- 5 – No, I have not used these resources

2. If yes, how have you used the resources, and which ones? (please select all that apply)

- 1 – To increase use of international standards
 - APEC Green Building Code Infrastructure Guide
 - Start-Up Guide, Building Information Modeling
 - APEC Guide to Performance Metrics and BIM to support Green Building Objectives
 - Building Codes and Standards: Minimum, Mandatory and Green
- 2 – To establish or expand stakeholder processes in green building codes or BIM
 - APEC Green Building Code Infrastructure Guide
 - Start-Up Guide, Building Information Modeling
 - APEC Guide to Performance Metrics and BIM to support Green Building Objectives
 - Building Codes and Standards: Minimum, Mandatory and Green
- 3 – To promote the incorporation of local market assessments of materials/products/ and technology into code measures
 - APEC Green Building Code Infrastructure Guide
 - Start-Up Guide, Building Information Modeling
 - APEC Guide to Performance Metrics and BIM to support Green Building Objectives
 - Building Codes and Standards: Minimum, Mandatory and Green

- 4 – To support policy development related to green building codes or BIM
 - APEC Green Building Code Infrastructure Guide
 - Start-Up Guide, Building Information Modeling
 - APEC Guide to Performance Metrics and BIM to support Green Building Objectives
 - Building Codes and Standards: Minimum, Mandatory and Green
 - 5 – Other: (please explain)

 - 6 – No, I have not used these resources
3. Did you attend any of the workshops held through this project? (please select all that apply)
- 1 – Lima, Peru, March 2013, Sharing Experiences in the Design and Implementation of Green Building Codes
 - 2 – June 2013, Medan, Indonesia, How Building Information Modeling Standards Can Increase Building Performance
 - 3 – August 2014, Beijing, China, Utilizing Building Information Modeling to Increase Building Performance
 - 4 – October 2014, New Orleans, Louisiana, *Utilizing Green Building Codes to Increase Building Performance*
 - 5 – No, I did not attend a workshop
4. If you attended one or more of the workshops listed above, to what extent did you find the workshops useful? (please select all that apply)
- 1 – Obtained new information on best practices used among APEC economies
 - 2 – Learned about new resources and provided input to their development
 - 3 – Gained a better understanding of opportunities for standards harmonization, and the regional and global value
 - 4 – Shared experiences developing and implementing green building codes and/or BIM with representatives from other economies
 - 5 – Made new contacts
 - 6 – Other benefits from participating: _____
 - 7 – Not relevant to my work
5. To what extent have you shared the resource(s) and/or information you learned during the workshop(s) with your colleagues?

- 1 – After returning from the workshop/training, I provided a formal presentation
- 2 – I have explained some aspects of the resources/workshop informally
- 3 – I have included information I gained from the resources and/or workshop in subsequent publications
- 4 – I shared the resources with others in my organization
- 5 – I shared the resources with colleagues outside my organization
- 6 – I have not shared resources/workshop information with my colleagues
- 7 – Other: (please describe) _____

6. Has the work on **green building codes changed any practices of your ministry/organization?**

- 1 – Yes, government or company **policy** has changed as a direct result of the resources/workshop
- 2 – Yes, government or company **practices** have changed as a direct result of the resources/workshop
- 3 – Yes, **coursework, academic papers, and/or research results** have changed as a direct result of the resources/workshop
- 4 – No changes have been made
- 5 – Changes have been made but unrelated to the resources/workshop

7. If no changes have been implemented at this time, has the work on **green building codes led to plans to change any practices of your ministry/organization?**

- 1 – Yes, there are plans to change government or company policy related to green buildings as a direct result of the resources/workshop
- 2 – Yes, there are plans to adopt new practices regarding green buildings as a direct result of the resources/workshop
- 3 – No, there are no plans to consider changing government or company policy or practices as a direct result of the resources/workshop

8. If you answered NO to the previous two questions, please select the response that best reflects your explanation as to why the resources/workshops did not support change: (please select all that apply)

- 1 – The resources/workshops are not relevant to my current responsibilities
- 2 – I do not have access to a network of relevant stakeholders
- 3 – The material is too technically difficult to implement
- 4 – I have insufficient resources to implement

- 5 – No directions have been provided from superiors to implement the practices/policies
- 6 – The best practices do not seem relevant to our economy/company/institution
- 7 – We currently implement all appropriate best practices

9. Has the work on **Building Information Modeling (BIM)** changed any practices of your ministry/organization?

- 1 – Yes, government or company **policy** has changed as a direct result of the resources/workshop
- 2 – Yes, government or company **practices** have changed as a direct result of the resources/workshop
- 3 – Yes, we have changed **coursework, academic papers, and/or research results** as a direct result of the resources/workshop
- Became involved in BIM standardization activities
- 4 – No changes have been made
- 5 – Changes have been made but unrelated to the resources/workshop

10. If no changes have been implemented at this time, has the work on **BIM** led to potential changes in any practices of your ministry/organization?

- 1 – Yes, there are plans to change government or company policy as a direct result of the resources/workshop
- 2 – Yes, there has been some discussion of developing plans to change government or company policy as a direct result of the resources/workshop
- 3 – No, there are no plans to consider changing government or company policy as a direct result of the resources/workshop

11. If you answered **NO** to the previous two questions, please select the response that best reflects your explanation as to why resources/workshops did not support change:

- 1 – The resources/workshops are not relevant to my current responsibilities
- 2 – I do not have access to a network of relevant stakeholders
- 3 – The material is too technically difficult to implement
- 4 – I have insufficient resources to implement
- 5 – No directions have been provided from superiors to implement the practices/policies
- 6 – The best practices do not seem relevant to our economy/company/institution

- 7 – We currently implement all appropriate best practices

12. Please give a concrete example of how your institution is applying the *green building codes* work:

- Introduced a baseline building code/regulations
- Added green components to existing building codes/regulations
- Referenced existing international standards and or codes
- Increased participation between experts in my economy and international standards committees
- Updated a building code or green code
- Engaged relevant stakeholders from my economy
- Conducted training or outreach activities
- Conducted reviews of code implementation to identify issues
- No actions taken
- Other: _____

13. Please give a concrete example of how your institution is applying the *BIM* work:

- First introduction to BIM for my ministry/organization
- Used BIM in government projects
- Referenced existing BIM standards
- Used in developing building/construction policies/regulations
- Joined BIM standards development in my economy
- Used BIM in general climate/green policy development
- No actions taken
- Other: _____

14. Which best practices identified during the project has or will your economy use to advance green buildings?

- Expanded or standardized stakeholder engagement processes
- Revised testing procedures that reflect a global standard
- Development of a conformity testing network
- Development of policies that promote efficient products in the market
- Establishment of a green building code

- Assessment of local market to determine availability of appropriate materials, products, and technologies
- Updating or strengthening measures in an existing green building code
- Other: (please explain) _____

15. What do you see as the key benefits of the work on green building codes and BIM (check all that apply?):

- Informal exchanges/communication with other APEC economies
- Learned about existing standards, codes and other guidance to apply in my economy
- Learned about the policies and programs of other economies
- Assisted in the green building decision making in my economy
- Networking opportunities with relevant stakeholders
- None
- Other [please describe] _____

16. Did your engagement in any element of this project accomplish the following?

- Advance leadership priorities of your economy
- Improve your organization's knowledge of global trends
- Support the introduction of technology changes in your economy
- Other: (please explain) _____

17. In which ways do you think the project could have been more effective or helpful?

- If the project included more building industry stakeholders
- If the project included more modeling demonstrations
- If the project included more opportunities for member economy representatives to engage with one another
- Other: (please explain) _____

18. Please provide any general comments on the resources and workshops:

ANNEX II: U.S. ADVISORY GROUP

Organization
Alliance to Save Energy (ASE)
Aluminum Association
American Association for Laboratory Accreditation (A2LA)
American Chemistry Council (ACC)
Air-Conditioning , Heating and Refrigeration Institute (AHRI)
American Institute of Architects (AIA)
American Institute of Steel Construction (AISC)
American National Standards Institute (ANSI)
American Society of Civil Engineers (ASCE)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
American Wood Council (AWC)
Applied Technology Council (ATC)
Armstrong
Associated General Contractors of America (AGC)
ASTM International
Autodesk
Bentley
bimSCORE
Cannon Design
City of Los Angeles
Continental Automated Buildings Association (CABA)
Fiatech
International Association of Plumbing & Mechanical Officials (IAPMO)
International Code Council (ICC)
Institute for Market Transformation (IMT)
McGraw Hill Construction

National Fire Protection Association (NFPA)
National Institute of Building Sciences (NIBS)
Green Building Initiative (GBI)
Plumbing Manufacturers Institute (PMI)
Stanford University, Center for Integrated Facility Engineering (CIFE)
Underwriters Laboratories (UL)
U.S. Green Building Council (USGBC)
VectorWorks
Virginia Tech, Earthquake Engineering Institute
WinBuild USA

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