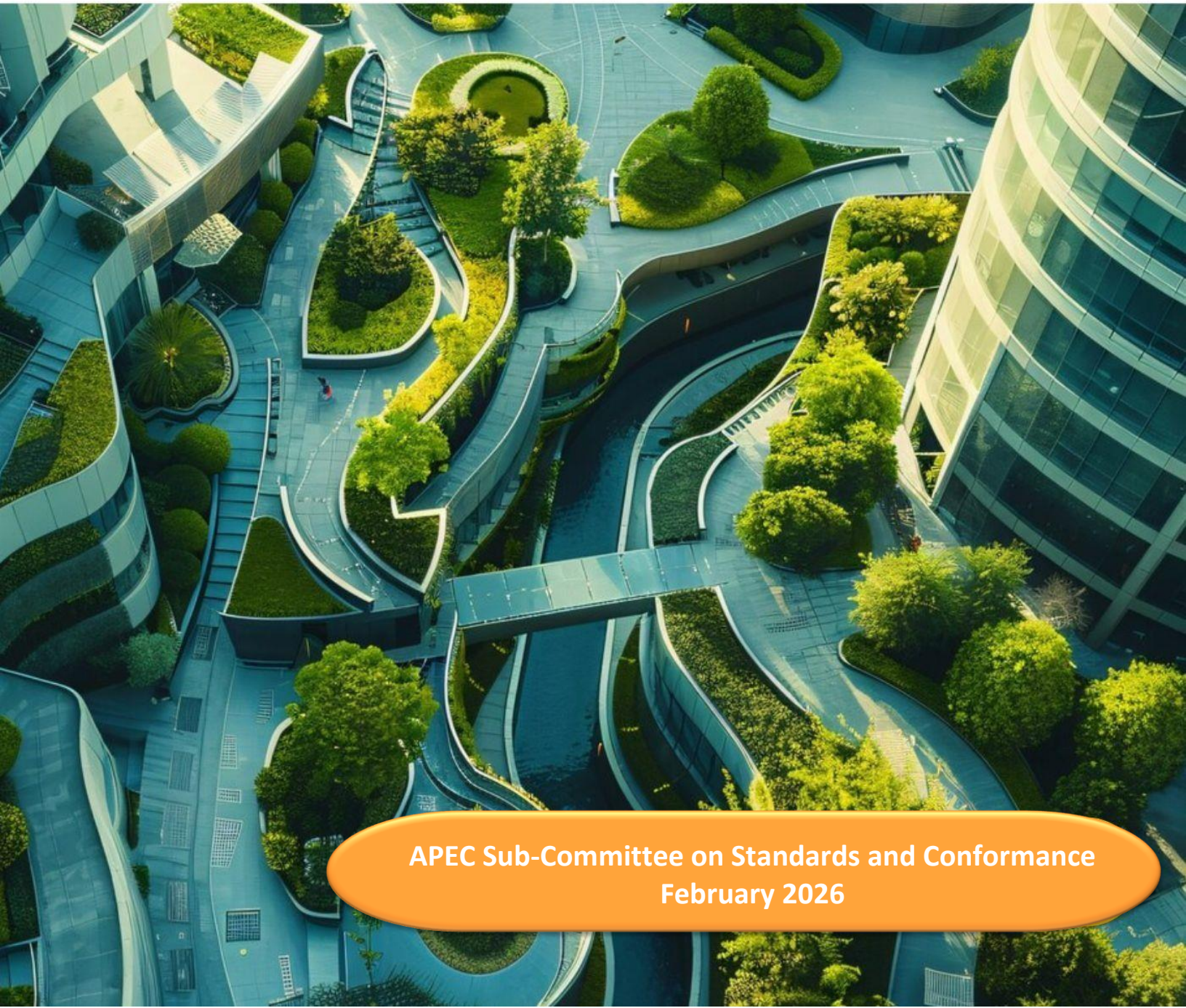
Asia-Pacific
Economic Cooperation

Enhancing Quality Infrastructure to Improve Green Material Utilization in the Building Structures



APEC Sub-Committee on Standards and Conformance
February 2026

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I. Introduction and Objectives of the Project

The APEC Project entitled “Enhancing Quality Infrastructure to Improve Green Material Utilization in Building Structures” was established in response to the increasing regional demand for sustainable construction practices and the global imperative to mitigate greenhouse gas emissions associated with the built environment. The building and construction sector continues to be a significant contributor to carbon emissions across APEC economies, driven both by operational energy consumption and the embodied carbon inherent in traditional construction materials such as cement, steel, and aluminum. These challenges underscore the critical need to accelerate the integration of greener, low-carbon, and resource-efficient materials in building practices.

The Preliminary Study, conducted as part of the project’s preparatory phase, identified several key gaps that hinder the widespread use of green materials. These include inconsistent definitions and classifications of “green materials,” varying degrees of maturity in quality infrastructure systems among APEC economies, limited awareness regarding international standards, and uneven access to testing, certification, and performance verification services. The study further highlighted the necessity for APEC economies to enhance their understanding of innovative material alternatives, including engineered bamboo, recycled composites, low-carbon binders, and bio-based materials, and the potential for incorporating these materials into existing building codes and procurement frameworks. These findings provided shape the project’s focus on strengthening conformity assessment systems, improving knowledge of standards, and enhancing stakeholder competencies.

Aligned with APEC’s broader sustainability agenda, including the Putrajaya Vision 2040 and commitments toward resilient and inclusive growth, the project positions quality infrastructure (QI) as a foundational enabler for greener construction practices. Reliable QI systems for standards, testing, accreditation, and certification are essential for building reliance in new and emerging green materials, supporting technology transfer, and reducing technical barriers to trade.

To advance these goals, the project convened a three-day workshop in Bali from 14-16 October 2025. This event brought together experts and key stakeholders from government

agencies, standards organizations, industry, academia, and international institutions. The workshop served as a platform to exchange knowledge on international standards and certification systems, explore innovative green materials, identify collaboration opportunities, and strengthen technical capacity across APEC economies. Presentations and discussions addressed current trends, regulatory challenges, technological advancements, testing requirements, and case studies from across the region.

The workshop also incorporated a site visit to local green material facilities, offering participants practical insights into real-world applications of sustainable materials in Indonesian building projects. Based on the discussions and inputs from the economies, recommendations were developed with a focus on enhancing cross-border cooperation, harmonizing standards, promoting life cycle thinking, and supporting broader market adoption of green materials.

Overall, this project aimed to bridge knowledge gaps, strengthen quality infrastructure, and promote the adoption of sustainable building materials across APEC economies. By integrating the findings from the Preliminary Study with regional dialogue and capacity building, it contributes to a shared vision of building structures that are not only safe and functional, but also environmentally responsible and aligned with global climate goals.

II. Project Activity

A. Preliminary Study

Green building has evolved from prescriptive rules to performance-based outcomes, driven by global sustainability commitments and urgent climate challenges. While adoption varies across regions, experiences from the Asia-Pacific region and selected pioneering projects demonstrate that measurable efficiency gains and material innovation can significantly transform the construction sector into a more low-carbon and resilient industry.

The global green building materials market is projected to grow from GBP 280.3 billion in 2024 to GBP 795.9 billion by 2033, reflecting an annual growth rate of about 12% (Ukpanah, 2024). Innovative products, such as structural insulated panels, are highlighted as industry game changers, offering both structural support and insulation

while reducing energy costs. However, the rapid increase in demand poses a risk of outpacing supply capacity.

While downstream businesses (closer to customers) increasingly commitments to sustainability, upstream and midstream stakeholders remain less engaged. Only 25% of glass manufacturers and 15% of concrete manufacturers have pledged sustainability commitments. Critically, just 2% of construction businesses have made similar commitments (World Economic Forum, 2023). Without strengthened supply-side measures, the growing demand for sustainable products may not be adequately met, potentially leading market participants to revert to conventional materials. Such a development would undermine broader sustainability objectives and impede progress toward low-carbon construction. To mitigate these risks, stakeholders are encouraged to expand supply capacity and reinforce sustainability commitments, thereby ensuring market stability and supporting long-term environmental goals.

The Asia-Pacific green building materials market reached GBP 83.4 billion in 2023, growing at 12.5% annually (Ukpanah, 2024). Strong growth momentum observed in several APEC economies demonstrates the significant potential for further market expansion. However, the successful scaling of green building materials depends on effective cooperation among public and private stakeholders to integrate these materials into existing supply chains and construction markets.

However, high costs of materials, lack of education, training, and familiarity with green technologies, and resistance from developers, unclear building codes, and limited policy incentives become challenges that can hinder green building materials expansion. Despite challenges, the future of green building materials is promising. Innovation, regulation, and market demand are accelerating adoption, positioning these materials as central to sustainable construction and global carbon reduction efforts.

Green building practices have evolved from a niche approach into a critical requirement for addressing climate change and environmental degradation. The achievement of sustainable infrastructure outcomes depends on the presence of a robust Quality Infrastructure (QI) system, encompassing standards, metrology, testing, and certification. These elements collectively ensure transparency, credibility, and

consistency in the green building sector by making environmental performance claims measurable and trustworthy, while also enabling market differentiation and supporting the achievement of sustainable development goals across APEC economies. As the Asia-Pacific region is home to several major global economies, strengthened domestic and cross-border cooperation is essential to overcoming existing barriers and accelerating the adoption of sustainable construction practices. In the absence of coordinated and balanced efforts across the construction value chain, the growth and market penetration of green building materials are likely to remain constrained.

Green building adoption across APEC economies demonstrates significant potential, particularly in emerging economies, but remains constrained by economic, regulatory, and technical barriers. Targeted policy incentives, harmonized standards, workforce development, and strengthened public–private collaboration are essential to unlocking market growth and realizing the region's sustainability potential. APEC economies can accelerate the adoption of green building practices by prioritizing innovative materials, promoting standards harmonization, investing in capacity-building initiatives, and fostering effective public–private partnerships. These findings will inform subsequent project phases and stakeholder workshops, with a focus on enhancing policy coherence and supporting practical implementation.

B. Workshop

The Workshop on Enhancing Quality Infrastructure to Improve Green Material Utilization in Building Structures was held over three days in Bali in October 2025. The workshop served as a capacity-building platform to support the development and implementation of policies, standards, and harmonization initiatives related to green materials across APEC economies. It aimed to convene stakeholders, regulatory authorities, and standards organizations to exchange insights and identify potential international standards and certification schemes that could serve as references for standard-setting processes.

The event was attended by experts from APEC economies, international organizations, green material producers and users, engineers, architects, contractors, academic institutions, and government representatives. Participants shared their knowledge and

experience regarding the application of green materials in building structures and discussed approaches to strengthening quality infrastructure systems to support broader and more consistent adoption.

The workshop presented a comprehensive overview of current trends, innovations, and policy directions in green material utilization across the APEC economy.

- Ms. Tiara Fitrida (PT Charlie Sierra Sierra Indonesia) highlighted that the construction sector contributes up to 40% of global CO_2 emissions. She emphasized three strategies; Avoid (design efficiently), Improve (use cleaner production), and Shift (adopt renewable materials such as engineered bamboo and geopolymer concrete). She also presented case studies, such as Green School Bali, Kopi Nako, and Potato Head, to illustrate the effective implementation of sustainable construction practices. She further emphasized that education, supportive regulatory frameworks, and policy incentives are critical enablers for accelerating the adoption of green building practices.
- Mr. Phuong Tran (Viet Nam IBST) outlined recent technological advancements in sustainable construction materials, including carbon capture applications in cement production, alternative binding materials, and engineered bamboo. He described Viet Nam's approach to adopting international standards with appropriate local adaptations and highlighted the importance of strengthened cooperation among APEC economies through standards harmonization, systematic knowledge sharing, and targeted capacity-building initiatives.
- Ms. Putu Nadi Astuti (Ministry of Industry, Indonesia) presented Indonesia's industrial decarbonization roadmap, supported by regulations and the Green Industry Certification (SIH) program for sectors such as cement, ceramics, and glass. She noted the government's 2060 net-zero commitment and the integration of efficiency, renewable energy, and circular economy principles into economy policy.
- Ms. Shirley Dewi (IAPMO R&T USA) presented recent developments in green construction material technologies, including bio-based, recycled, and smart adaptive materials. She emphasized the importance of robust testing, certification, and performance standards to ensure product quality and

sustainability, with reference to established international frameworks such as ASTM and ANSI.

- Mr. Kun Chen (UL Solutions) underlined the role of Life Cycle Assessment (LCA) and Environmental Product Declarations (EPD) in tracking carbon footprints and ensuring transparent sustainability claims. He noted the influence of global policies like the EU's CBAM and US Buy Clean initiatives in promoting low-carbon procurement.
- Mr. Prasetyoadi (Green Building Council Indonesia) shared insights from the implementation of green building certification in Indonesia, with a focus on circular economy principles, the use of local materials, and strategies to address cost-related and behavioral barriers. He emphasized the importance of collaboration among government, industry, and academia to support the mainstream adoption of green materials and their eventual integration into mandatory construction requirements.

Overall, the sessions underscored three key messages: the need for regulatory support to complement technological innovation, the importance of education in driving behavioral change, and the role of standards harmonization in scaling the adoption of green materials across APEC economies.

A workshop evaluation survey was shared to gather feedback from all participants following the conclusion of the event. The purpose of the survey was to assess the workshop's effectiveness in terms of topic relevance, speaker presentations, overall impact, and suggestions for future improvement or activities. Out of the total number of participants, a commendable 45 individuals (representing 75% of the total participants) completed the evaluation survey. The results indicate a high level of satisfaction, with 94.67% of respondents selecting “Strongly Agree” or “Agree” across the assessed criteria. For further details, please refer to the following details:

Table 1. Workshop Evaluation Survey

Results	Attribute	Score
1	Relevance to me	4.93
2	Applicability to my work	3.98
3	Delivery of content	4.82
4	Pace of delivery	4.73
5	Instructor suitability	4.91
6	Materials provided	4.91
7	Interest in further workshops	4.29

The workshop achieved highly positive outcomes, indicating strong participant interest and a clear demand for continued engagement in this area. Overall assessments were favorable, with the majority of participants rating the workshop components as “very good,” and a number of respondents providing an “excellent” rating.

A standout feature that garnered substantial appreciation was the opportunity for participants to engage in small group discussions, workshopping best practices, and exploring new technological introductions throughout the day. This participatory approach was widely regarded as a key strength of the workshop and contributed positively to participant engagement and learning.

Participants also provided constructive feedback for improvement. Suggested enhancements included more structured group sessions focused on specific thematic areas, extending the duration of the workshop to allow for deeper discussion, and the provision of online interpretation services to facilitate effective communication among participants from diverse economies.

C. Site Visit

A site visit was conducted to demonstrate the practical application of green materials within Indonesian businesses. This activity provided participants with best-practice examples and strengthened awareness of implementation opportunities in real project settings. In addition, representatives from APEC economies contributed to the development of a set of recommendations. The resulting document reflects collective input and outlines strategies and best practices to promote the wider utilization of green materials in building structures across the Asia-Pacific region.

The first site visit was to ECOLLABO8, a Bali-based company specializing in the processing of post-consumer recycled plastics. The company produces weather-resistant panels, known as “ecotiles,” as well as furniture and decorative and architectural elements. Their product line contains approximately 90% recycled content, exceeding the common 50% benchmark used in eco-certifications, which was validated through compressive strength testing to ensure material reliability.

The company operates on a B2B/project-based model, focusing on large-scale contracts rather than retail sales. ECOLLABO8 intentionally avoids external “eco/green” labels, instead relying on stricter internal standards. ECOLLABO8 future growth will focus on the Bekasi plant, aimed at increasing waste processing capacity and improving supply to urban markets. Furthermore, commercial strategy emphasizes large-scale projects to maintain consistency in quality, volume, and after-sales service.

As part of the site visit, participants were introduced to BDK (*Balai Diklat Keagaaman*) Denpasar as a representative example of public sector implementation of green building practices in Indonesia. BDK Denpasar received Green Building Certificates (*Bangunan Gedung Hijau*) from the Ministry of Public Works and Housing (PUPR) in May 2024. The certification covers several facilities including Dormitory I & II, Training Building, Office Building, and praying room (Musholla). All buildings achieved *Madya* (Intermediate) rating under the BGH assessment system.

Under the BGH evaluation, BDK achieved performance compliance score 114 out of 165 assessed across seven criteria. This Included Energy Efficiency (35/46), Site Management (25/38), Water Efficiency (10/22), Indoor Air Quality (14/19), Environmentally Friendly Materials (18/21), Solid Waste Management (5/7), and Water

Waste Management (7/12). BDK demonstrated compliance through use of non-toxic paints, bamboo/renewable materials, rust-resistant coatings, adoption of eco-labeled materials (ISO 14001-certified cement, local concrete, recycled wood, asbestos-free roofing), legal wood procurement under SVLK certification, and domestic component content (TKDN) ≥40%, supporting local industry and domestic economic growth.

BDK Denpasar has successfully integrated green building principles across its facilities with Eco-Office Management Practices:

- Waste Management: Segregation of organic, inorganic, and recyclable waste; composting initiatives.
- Energy Saving: Motion sensor lighting, solar-powered lamps, and maximized natural lighting.
- Water Efficiency:
    - Wastewater reuse from handwashing for garden irrigation.
    - Rainwater harvesting system for toilet flushing.

BDK shows their commitment by achieving *Madya* rating, reflects strong performance in energy efficiency and environmentally friendly materials. They need to have continuous improvement in water efficiency and site management to reach higher certification levels. Their practices demonstrate alignment with domestic sustainability policies and contribute to institutional environmental responsibility.

The last visit was to Ecocrete Indonesia (Ecocrete), a green technology company specializing in low-carbon and sustainable concrete solutions. Established in 2016 and headquartered in Bali, the company aims to support the transformation of Indonesia’s construction sector through the application of eco-efficient materials, circular economy principles, and sustainable production practices.

The Ecocrete visit highlighted the important role of private sector innovation in advancing sustainable construction. Through the integration of eco-efficient technologies and alignment with international standards, Ecocrete demonstrates how industry-led solutions can complement quality infrastructure initiatives and contribute to the transition toward low-carbon building systems. Ecocrete Indonesia develops eco-concrete and green construction materials that reduce the environmental impact

of traditional cement products. Its approach emphasizes:

- Lower CO_2 emissions through substitution of Portland cement with supplementary materials (fly ash, GGBFS, rice husk ash).
- Recycling industrial waste and optimizing resource efficiency in production.
- Maintaining strength and durability in compliance with SNI and ASTM standards.

The company's practices align with the UN Sustainable Development Goals (SDGs), specifically Goals 9, 11, and 13, demonstrating how local innovation can advance Indonesia's transition to a low-carbon, circular, and resilient construction sector.

The visit observed practical applications of green materials and understand sustainability frameworks in Ecocrete's production model, with observation in several key elements, namely:

- Cement Replacement & Emission Reduction: Up to 60% cement substitution; ~40% CO_2 reduction per cubic meter.
- Recycling & Circularity: Integration of recycled aggregates and industrial waste.
- Water & Energy Efficiency: Closed-loop water systems and energy-optimized batching technologies.
- Durability & Lifecycle Performance: Longer service life, reduced repair frequency, lower lifecycle carbon impacts.
- Standards & Quality Infrastructure: Application of ISO 14021 and ISO 14067; collaboration with BSN and local labs.
- Certification Alignment: Supports GBCI and LEED criteria; active in research and pilot projects with government and academia.

Ecocrete gave insights to participants about innovation as decarbonization driver, standardization importance, market readiness, and challenges faced. This visit resulted in:

- Enhanced understanding of practical frameworks for green material utilization.
- Identification of best practices in standardization, testing, and certification.
- Strengthened dialogue between industry and regulators.

- Basis for policy recommendations to advance low-emission construction systems across APEC economies.

III. Pre-Workshop and Post-Workshop Evaluation

Participants were encouraged to complete a pre-evaluation before the workshop as a baseline knowledge of participants regarding the workshop and a post-evaluation at its conclusion to determine the effectiveness of learning outcomes. Both assessments consisted of 10 corresponding true/false and multiple-choice questions that examined similar areas of workshop knowledge substances.

Table 2. Pre-Workshop and Post-Workshop Evaluation Questions

No	Question
1	What is “green material” in the context of construction?
2	“Embodied carbon” refers to emissions from:
3	True or False. Setting up domestic LCA databases and enabling mutual recognition of verified EPDs is an effective way to grow a credible market for green materials across a region.
4	Which standards define core LCA principles and requirements?
5	True or False. If two EPDs use different declared units, you can compare their GWP values directly without conversion.
6	A Product Carbon Footprint (PCF) typically reports:
7	Product Category Rules (PCR) are used to:
8	True or False. The built environment (operational + embodied) is responsible for roughly 40% of global greenhouse-gas emissions.
9	For mass timber, certification like FSC/PEFC mainly ensures:
10	Which standard governs Type III environmental declarations (EPDs) for products?

The results served as comparative data to measure changes in participants’ understanding before and after the workshop. A total of 50 participants, representing 96% of all attendees, successfully completed both assessments. All participants who completed both tests achieved higher scores on the post-test than on the pre-test. On average, participants’ level of understanding increased to 97% after the workshop, reflecting a 12.4% improvement in knowledge. Figure 2 presents the percentage of correct responses in both the pre-evaluation and post-evaluation.

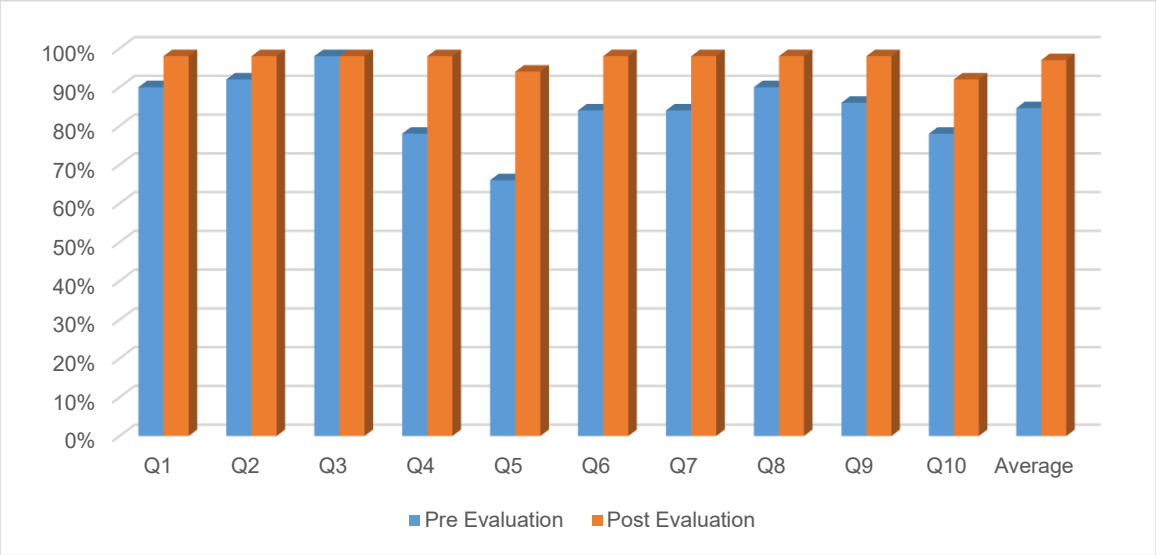

Figure 1. Pre and Post Evaluation Result

IV. Recommendation

The project concluded with several key recommendations to enhance the adoption and implementation of green materials in building structures across APEC member economies:

- Strengthened Quality Infrastructure (QI): Develop and align systems for standards and conformity assessment procedure to ensure credibility and trust in green material performance. A robust QI framework enables more efficient permitting processes, reduces trade barriers, and enhances market confidence.
- Harmonize International or Economy-wide Standards: Encourage APEC economies to harmonize or mutually recognize standards and conformity assessment schemes to enable smoother cross-border trade and promote global acceptance of sustainable materials. When international standards are unavailable, economies may refer to mutually agreed standards to maintain consistency and compatibility.
- Promote Life Cycle Thinking: Integrate Life Cycle Assessment (LCA) and Environmental Product Declarations (EPD) into domestic best practices and public procurement to quantify and monitor the environmental impact of materials throughout their lifespan.
- Strengthening Capacity Building and Knowledge Sharing: Provide training programs and technical workshops for architects, engineers, contractors, and SMEs

to enhance their understanding of sustainability standards, documentation, and performance-based design.

- Encourage Green Public Procurement (GPP): Governments are encouraged to lead by example by integrating sustainability criteria into infrastructure projects, prioritizing materials with certified low-carbon or eco-friendly attributes.
- Foster Innovation and Private Sector Collaboration: Support public–private partnerships (PPP) and innovation hubs to accelerate research, pilot projects, and commercialization of new green materials, particularly in developing economies.
- Provide Incentives and Financial Support: Introduce tax incentives, subsidies, or carbon credits to motivate industries to transition toward sustainable material production and certification.
- Promote Public Awareness and Education: Enhance public communication on the benefits of green materials and sustainable construction, linking environmental action to tangible societal and economic impacts.
- Adopt Circular Economy and Local Resource Principles: Encourage the use of locally available, renewable, and recyclable materials to reduce embodied carbon, transportation emissions, and resource depletion, while supporting community-based industries.
- Sustain APEC Collaboration: Establish a platform for continuous dialogue and data exchange among APEC economies to share case studies, best practices, and progress in promoting low-carbon and sustainable built environments.
- Based on workshop findings, including the identification of new building material innovations, potential inter-standard alignment opportunities, training needs, and guideline development, the workshop recommends establishing an APEC-wide Green Material Knowledge & Capacity Platform. This platform would:
    1. Capture and catalogue emerging green material innovations identified during the workshop (e.g., engineered bamboo, recycled composite panels, low-carbon binders, mycelium-based materials).
    2. Facilitate dialogue among standards bodies to explore potential alignment of green building and green material standards, including performance-based requirements, LCA/EPD frameworks, and cross-border recognition mechanisms.

3. Host training modules for engineers, architects, contractors, SMEs, and regulators, reflecting topic areas highlighted in the workshop, such as circularity practices, LCA, EPD, sustainable procurement, and GBCI's MRC (Material Resources & Cycle) credits.
4. Provide a repository of guideline materials, including model procedures, best practices, and policy templates to support economies in developing economy-wide guidance on green materials, circular design, and sustainable construction.

V. Conclusion

The project was delivered to emphasize environmental sustainability by reducing carbon emissions, conserving natural resources, and minimizing the ecological footprint of building construction. Through a combination of study, workshop, and study visit activities, the project successfully served as a platform for stakeholders, regulatory bodies, and standards organizations from APEC economies to collaborate and share ideas and knowledge. The event fostered comprehensive discussions aimed at identifying potential international standards and certification schemes for green materials.

Additionally, the study visit provided first-hand exposure to innovative, industry-driven green material practices and their integration into the Indonesian construction ecosystem. These discussions emerged new insights on material innovation as a driver of decarbonization, standardization linkage which underscores the importance of harmonized quality infrastructure in advancing green material adoption, market readiness, challenges and policy support needs. This activity resulted in:

- Enhanced understanding of green material utilization frameworks in practice.
- Identification of best practices for standardization, testing, and certification in low-carbon construction materials.
- Strengthened dialogue between industry and regulators on enabling conditions for sustainable materials.
- Insights into policy recommendations to advance APEC economies' transition to low-emission construction systems.

In essence, the project urged APEC economies to combine innovation, regulation, and collaboration, building a common framework of trust through measurable standards, verified performance, and sustained economies cooperation.

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Annex A: Overview of the Workshop Sessions and Field Trip

I. Workshop Presentations

The workshop invited speakers from different backgrounds of expertise, such as government representatives, regulatory bodies, standards organizations, and business representatives. The three-day workshop opened with a keynote address delivered by Konny Sagala, Director of Laboratory Accreditation at the National Standardization Agency of Indonesia.

DAY I

Opening speech

Ms. Konny Sagala – Director of Laboratory Accreditation, National Standardization Agency of Indonesia.

- The building and construction sector is essential in shaping communities and influencing people's lives. At the same time, it significantly contributes to global carbon emissions. Therefore, the quality and sustainability of infrastructure are crucial for both societal well-being and environmental preservation.
- Green construction materials are fundamental to achieving this balance. Their environmental performance, durability, and cost-effectiveness must be demonstrated through credible testing and certification processes, including those developed by ISO and relevant United Nations standards. These mechanisms help ensure that advancements in construction are consistent with global sustainability principles.
- The overarching objective is to develop materials that perform reliably, methods that can be independently validated, and buildings that can be delivered responsibly for the benefit of both people and the environment. Collaboration among architects, engineers, regulators, industry representatives, and other stakeholders remains essential to ensure that sustainability standards are not only formulated but also implemented effectively.
- This workshop aligns with the APEC Putrajaya Vision 2040 and supports the UN Sustainable Development Goals (SDGs), particularly Goal 9 (Industry, Innovation, and Infrastructure), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action).

- Every economy faces unique challenges in achieving sustainability; however, these challenges are interconnected. Establishing consistent certification and conformity standards can help reduce technical barriers to trade, enhance safety and performance, and support the adoption of green materials across the global supply chain.
- Ultimately, the discussions in this workshop emphasize a shared commitment to ensure that our homes and infrastructure are not only safe and affordable, but also sustainable and trusted by the market.

Moderator: Rois Ricaro – National Standardization Agency of Indonesia

Session 1: Current Trends and Challenges in Green Material Utilization.

Ms. Tiara Fitrida – PT. Charlie Sierra Sierra Indonesia.

A Deep Dive into the Current Landscape of Green Material Application and its Associated Challenges

- In her address, Ms. Tiara Fitrida emphasized the urgency of rethinking how societies design, build, and sustain their infrastructure in the face of growing environmental challenges. She began by inviting participants to reflect on the current landscape of green material application and the persistent structural barriers that hinder its widespread adoption. Her presentation focused on three core forces shaping the transformation of the construction industry: policy frameworks that drive change, material efficiency supported by innovation, and cross-sector collaboration connecting public and private stakeholders. Together, she noted, these three dimensions form the backbone of sustainable transformation across the entire construction ecosystem.
- To ground the discussion, Ms. Tiara presented a case study from the Bali Flood of September 2025, a devastating event that demonstrated how unbalanced urban growth, tourism development, and climate vulnerability are closely intertwined. She highlighted that this was not an unforeseen disaster; as early as 2018, research by Kusmiarti et al. had predicted flood-prone expansion in Bali's southern corridor. She explained that the absence of adequate land-use regulation and green infrastructure

turned economic progress into climate risk. She argued, embodied “the cost of inaction” and reinforced that sustainability must begin with sound planning, energy efficiency, and responsible material use.

- Ms. Tiara reminded the audiences that the building and construction sector contributes around 37–40% of global CO_2 emissions, amounting to roughly 15 billion tons annually. Two-thirds of these emissions come from building operations, heating, cooling, and power while the remaining one-third originates from the production of construction materials. Although operational emissions are slowly declining due to cleaner energy systems, embodied carbon from materials like steel and cement continue to rise, making material efficiency one of the strongest levers for decarbonization.
- She explained that nearly three-quarters of emissions in large infrastructure projects come from materials and fuel rather than on-site activities. For example, steel alone accounts for about 30% of total emissions, concrete for 25%, and other materials such as aluminum, asphalt, and plastics for another 13%. This data reinforces the message that what we build with is just as important as how we build. According to Ms. Tiara, the path to a low-carbon future requires three simultaneous shifts:
    1. Avoid – build with less through design efficiency and modularity.
    2. Improve – lower the carbon footprint of conventional materials through recycling and cleaner production.
    3. Shift – expand the use of renewable and regenerative materials.
- The transition toward low-carbon and circular materials is already accelerating. Ms. Tiara noted that construction today is still dominated by carbon-intensive materials such as steel, cement, and glass, but projections toward 2060 indicate a steady rise in bio-based, recycled, and renewable alternatives, including engineered bamboo, geopolymer concrete, hempcrete, mycelium bricks, and recycled composites. These innovations, she emphasized, prove that sustainability does not mean compromise; in fact, many of these materials outperform traditional ones in durability, performance, and cost-effectiveness.

- Quoting the World Green Building Council, Ms. Tiara highlighted that achieving net-zero embodied carbon must be part of a “whole-life carbon approach” from material extraction to end-of-life reuse. She added that the building materials sector is shifting from heavy industry to high technology, with innovations such as self-healing concrete and carbon-negative binders redefining the limits of what’s possible. “We are not only redesigning buildings,” she said, “we are redesigning the material economy that builds them.”
- The market potential for green materials is significant. The global market is projected to reach USD 458 billion by 2030, growing at nearly 10% annually. In APEC economies, this transformation is already visible: Australia and Singapore are leading in embodied carbon disclosure and public procurement reforms; Japan and Korea are advancing innovation through industrial research partnerships; while Indonesia; Thailand; and Viet Nam are showing rapid progress through private-sector initiatives. She noted that this dual momentum, policy guidance from governments and innovation from developers, is turning sustainability into a mainstream business model.
- Ms. Tiara underlined that policy alignment, certification, and education are essential for accelerating green material adoption. Governments can support the transition through incentives such as tax reliefs, carbon credits, and recognition programs; standards, by harmonizing embodied carbon reporting and certification systems; and education, through upskilling programs for engineers, architects, and builders. Bridging these elements ensures that sustainability becomes both practical and profitable.
- To make her message tangible, Ms. Tiara showcased several inspiring case studies from Indonesia:
    1. Ibuku’s Green School in Bali, which demonstrates how vernacular materials, supported by research and certification, can achieve modern structural standards while redefining luxury through sustainability.
    2. Kopi Nako, whose brand identity is built on circular design, proving that even small-scale commercial projects can successfully embed environmental principles into business culture.

3. Potato Head Bali, a hospitality project that functions as a living lab for circular economy practices, showing that sustainability and creativity can coexist beautifully in architecture.

- She also addressed emerging innovations such as recycled plastic paving blocks, which have become popular in community-led projects across Indonesia. While acknowledging their creativity and civic value, she also underscored the importance of regulation and certification to avoid unintended consequences such as microplastic pollution. “We don’t need to stop innovation,” she said. “We need to guide it, so that passion becomes progress.”
- In closing, Ms. Tiara delivered a powerful call to action: “The buildings we design today define the climate we live in tomorrow.” She urged participants to view every design, policy, and procurement decision as an opportunity to accelerate decarbonization and circularity. Her final message was one of shared responsibility: only through collective collaboration, between governments, industries, and communities can the Asia-Pacific economies transform itself from a fast follower into a global leader in sustainable construction.

Session 2: Innovation in Sustainable Building Materials

Phuong Tran – Viet Nam Institute for Building Science and Technology, Ministry of Construction, Viet Nam

Building Green Futures: Breakthroughs in Sustainable Material Technology

- Mr. Phuong Tran began his presentation by expression his appreciation to the organizers for the opportunity to discuss a significant topic: green building materials and low-carbon technologies. As the Head of the Green Building and Energy Efficiency Department at IBST, Mr. Tran has been actively involved in developing Viet Nam’s roadmap for decarbonization in the construction sector, in collaboration with international partners such as the IFC, GlobalABC, BSI, and Standards Australia.
- Mr. Phuong Tran emphasized that the building and construction industry contributes around 37% of global energy-related CO_2 emissions. He distinguished between operational carbon emissions from building use (e.g., electricity and HVAC) and

embodied carbon, which comes from material extraction, manufacturing, and construction. Advancements in building energy efficiency have reduced operational emissions over time, thereby increasing the relative significance of embodied carbon. This shift reinforces material innovation as an essential pathway for achieving comprehensive decarbonization.

- Drawing from UNDP and other global frameworks, Mr. Tran outlined three major strategies:
    1. Avoiding waste and overbuilding by ensuring that materials are used only where necessary.
    2. Utilizing bio-based and renewable materials, such as engineered timber and bamboo.
    3. Improving conventional materials and production processes, particularly in the cement and concrete industries.
- He then presented five technological strategies to reduce emissions in concrete production:
    1. The utilization of supplementary cementitious materials (SCMs), including fly ash and agricultural by-products.
    2. The application of carbon capture, utilization, and storage (CCUS) technologies within cement manufacturing processes.
    3. The facilitation of natural recarbonation, through which concrete reabsorbs CO_2 over the course of its service life.
    4. The adoption of alternative binders and low-carbon energy sources, such as hydrogen-powered cement production facilities.
    5. The implementation of design and production optimization measures, which can reduce emissions by up to 33 percent through enhanced structural efficiency without requiring substantial technological investment.
- Mr. Tran highlighted the growing potential of engineered timber, bamboo, and agricultural residue composites as sustainable alternatives to traditional materials.

1. Advanced timber technologies allow for high-rise structures using prefabricated wooden components, with significant carbon savings and shorter construction times.
2. Engineered bamboo and recycled composites offer comparable strength and flexibility while drastically lowering embodied carbon.
3. Biomass-based insulation materials from rice husks or straw have shown great potential in Viet Nam and are now being exported internationally.

- He also shared examples of projects in Australia; Japan; and Viet Nam demonstrating how wood and bamboo-based buildings can meet modern safety and fire resistance standards.
- Despite the promising technological developments, Mr. Tran emphasized that several critical barriers continue to impede large-scale adoption:
    1. Regulatory and standardization gaps remain significant, as many emerging economies do not yet possess harmonized codes for novel materials, thereby complicating certification processes and hindering market uptake.
    2. High investment costs and infrastructure constraints also pose major challenges, given that technologies such as CCUS and hydrogen-based production require substantial upfront capital and specialized facilities.
    3. Performance verification and the need to ensure fair competition present additional obstacles, such as the lack of reliable data, testing mechanisms, and certification platforms can discourage private-sector participation.
    4. The imperative of ensuring a transition further underscores the need for comprehensive retraining and capacity-building initiatives to support workers and communities as the sector shifts toward low-carbon materials.
- He cited the example of Viet Nam’s modular housing industry, where locally produced low-carbon modules cannot yet be used domestically due to the absence of economy-wide standards, despite meeting international quality benchmarks.
- Mr. Tran concluded by advocating for the development of a collaborative APEC-wide roadmap for sustainable materials, structured around four key pillars:

1. Harmonizing standards: developing unified LCA and EPD frameworks across APEC to reduce trade barriers.
2. Sharing knowledge and best practices: creating open platforms for cross-economy learning on policies, technologies, and project experiences.
3. Building capacity and infrastructure: ensuring developing economies have access to training, investment, and technical assistance.
4. Public-private partnership (PPP): combining government incentives and private innovation to accelerate deployment and scale up.

- Mr. Tran concluded by reaffirming that the green material transition is not only a technological necessity but also an economic opportunity. By embracing sustainable materials, APEC economies can lead the world in developing resilient, livable, and zero-carbon cities. He urged all stakeholders, governments, researchers, and the private sector to collaborate in shaping a future where innovation and sustainability go hand in hand.

Putu Nadi Astuti – Directorate of Cement, Ceramic, and Non-Metallic Mineral Processing Industries, Ministry of Industry of Indonesia

Challenges and Opportunities in Policy Implementations of Green Materials

- Ms. Putu delivered an insightful presentation on Indonesia's regulatory framework, industrial decarbonization strategy, and the implementation of green industry policies, highlighting Indonesia's commitment to building a sustainable and competitive industrial base.
- She began by explaining that Indonesia's transition toward a low-carbon and resource-efficient industry is underpinned by a strong regulatory foundation. Several key laws and regulations form the backbone of this commitment:
    1. Law No. 3 of 2014 on Industry, which emphasizes the development of an independent, competitive, and sustainable green industry.
    2. Law No. 16 of 2016, ratifying the Paris Agreement, reaffirming Indonesia's alignment with global climate goals.

3. Government Regulation No. 14 of 2015 on the National Industry Development Master Plan 2015–2035, which highlights innovation and environmental preservation.
4. Government Regulation No. 29 of 2018 on Industrial Empowerment, mandating the implementation of Green Industry Certification.
5. Presidential Regulation No. 98 of 2021, which introduces the concept of carbon economic value as a tool to achieve Indonesia's emission reduction targets.

Mandatory Indonesian National Standards (SNI) are enforced for key products such as cement, ceramics, glass, and insulation materials to ensure product quality, safety, and environmental compliance. Together, these instruments form an integrated framework that supports Indonesia's transition toward greener and more competitive construction materials industries.

- Ms. Putu reaffirmed Indonesia's strong commitment to the Paris Agreement and subsequent Conference of the Parties (COP) decisions. In its Enhanced Nationally Determined Contribution (NDC), Indonesia targets a 31.89% reduction in greenhouse gas emissions through domestic efforts and 43.20% with international support.
- At COP28, Indonesia reiterated its goal to achieve net zero emissions by 2060 or earlier, supported by flagship projects such as the North Kalimantan Green Industrial Park, envisioned as the world's largest green industrial hub.
- The industrial sector contributes approximately 34% of Indonesia's total emissions, nearly half of which come from energy-intensive subsectors such as cement, ceramics, and glass.
- To address this, the Ministry of Industry has established an ambitious target: a 93.5% reduction in industrial emissions by 2045, with the goal of reaching a net-neutral industrial sector by 2050 in alignment with Indonesia's net-zero objective.
- To achieve these goals, the Ministry is developing a comprehensive roadmap for industrial decarbonization, focusing on:
    1. Transitioning to cleaner energy sources,
    2. Improving energy and resource efficiency, and

3. Promoting the adoption of low-carbon technologies.

- For the cement industry, a specific roadmap has been completed and will be formalized through regulation. The measures include:

    1. Reducing the clinker factor by using alternative raw material;
    2. Increasing biomass and alternative fuel use;
    3. Expanding solar power installations;
    4. Enhancing energy efficiency through waste heat recovery systems; and
    5. Introducing carbon capture technologies.

- Similar roadmaps for the ceramic and glass industries are under preparation, aimed at transforming Indonesia's building materials industry into a low-carbon, energy-efficient sector that fully supports the Net Zero 2050 goal.

- To ensure that industrial transformation is measurable and continuous, Indonesia has established the Green Industry concept under Law No. 3 of 2014. A green industry is defined as one that prioritizes efficiency and effectiveness in resource utilization, ensuring sustainability in every stage of production. This framework rests on three main pillars:

    1. Resource Efficiency: optimizing material inputs, using renewable raw materials, minimizing energy and water consumption, and applying circular economy principles.
    2. Environmental Function: managing industrial waste and emissions effectively to reduce greenhouse gas output.
    3. Social Benefit: empowering communities and developing sustainable human resources to ensure equitable industrial growth. In essence, the green industry aligns with Indonesia's broader green economy vision, characterized by low emissions, efficient resource use, and social inclusiveness.

- To accelerate adoption, the Ministry of Industry has introduced the Green Industry Standard or known as Sertifikasi Industri Hijau (SIH) as a practical and measurable framework for sustainable industrial operations. This standard currently prioritizes nine subsectors, including cement, ceramics, and glass, all key contributors to

Indonesia’s construction materials supply chain. The technical requirements under SIH cover:

1. Raw materials, energy, and water management,
2. Production processes, packaging, and product standards, and
3. Waste and greenhouse gas management.

- In addition, management requirements ensure strong governance and continuous improvement through:

  1. Clear policy and organizational structure,
  2. Strategic planning and implementation,
  3. Monitoring and internal audit, and
  4. Corporate Social Responsibility (CSR) integration.

- So far, more than 30 companies in the cement, ceramic, and glass sectors have been awarded Green Industry Certification by the Ministry of Industry, recognizing their commitment to sustainable and efficient production practices.
- Complementing the green industry framework, Indonesia also enforces energy efficiency standards under the Minister of Energy and Mineral Resources Regulation No. 8 of 2025. This regulation requires industries to:

  1. Appoint energy managers,
  2. Conduct regular energy audits, and
  3. Track key performance indicators for continuous improvement.

  Such measures not only help reduce emissions but also enhance operational efficiency, cost competitiveness, and resilience in the global shift toward clean energy.

- In closing, Ms. Putu emphasized that Indonesia recognizes the importance of domestic and international cooperation in achieving industrial sustainability. Through the ASEAN Consultative Committee on Standards and Quality – Building and Construction Working Group (ACCSQ BCWG), Indonesia actively supports the harmonization of green and smart city standards across ASEAN.

- Beyond the economy, Indonesia collaborates with partners such as the European Union; Korea; and the United States on programs promoting sustainable and resilient building materials. These partnerships, Ms. Putu noted, are crucial in strengthening domestic capacity, reducing technical barriers to trade, and accelerating the transition toward low-carbon, competitive, and inclusive industrial growth.

DAY II

Moderator: Eka Puspitawati – Pertamina University, Indonesia

Session 3: The Latest Development in Green Material Technologies.

Presentation by Ms. Shirley Dewi – IAPMO R&T USA

Cutting-Edge and Sustainable building Material Technologies in the USA and Study Cases

- Ms. Shirley Dewi opened her presentation by addressing common misconceptions regarding green construction materials, particularly the belief that they are inherently more expensive. She clarified that sustainable construction materials offer significant advantages, including enhanced energy efficiency through reduced energy consumption, lower emissions during both construction and a building's operational lifecycle, and increased durability, which decreases long-term maintenance and replacement costs. These benefits collectively enable buildings to perform more efficiently while minimizing both financial and environmental resource use.
- Ms. Dewi explained that green construction materials take various forms. Bio-based materials, such as hempcrete and bamboo, provide renewable alternatives for construction and manufacturing. Recycled-content materials, such as reclaimed steel or recycled plastics, help reduce waste by integrating reused materials into new products and promoting circular economy principles. Additional commonly used green materials include algae-based insulation, mycelium composites, recycled plastics, and repurposed materials used for structural panels, roofing tiles, and insulation boards.
- She noted that green materials increasingly incorporate smart and adaptive technologies. Examples include sensor-embedded materials designed to monitor

environmental conditions and structural integrity in real time. Many advanced materials also possess self-healing capabilities or enhanced resistance to environmental stressors, thereby improving building lifespan, safety, and long-term performance.

- Ms. Dewi highlighted the important role of the American Society for Testing and Materials (ASTM), which develops product standards for building materials. These standards include diverse testing methods and specifications that evaluate material performance and ensure that sustainability criteria are met.
- She further described the roles of key standards organizations. IAPMO, for instance, develops standards that promote water health, plumbing safety, and energy efficiency in the built environment. ANSI, meanwhile, serves a coordinating role by fostering uniformity and quality across industries and promoting conformity assessments to verify compliance and strengthen market trust.
- Ms. Dewi outlined the primary testing protocols required for a product to qualify as green material. These include:
    - Durability testing, which assesses material strength and lifespan under different conditions.
    - Thermal testing, which measures insulation properties and evaluates energy efficiency.
    - Moisture resistance testing, which determines the material's ability to withstand exposure to water and prevent related damage.
- Environmental testing, which analyzes a material's ecological footprint and overall sustainability.
- Ms. Dewi concluded by reflecting on the evolution of green building reinforcement in the United States, which progressed from voluntary rating systems to mandated requirements and, eventually, to fully regulated implementation. She emphasized that Indonesia is at the early stages of adopting comparable measures. To ensure successful implementation, she stressed the importance of comprehensive planning and design, improved energy efficiency, and enhanced environmental quality, particularly indoor air quality.

Kun Chen – UL Solutions

Monitoring and Enforcement within Policy and Regulatory Frameworks for Promoting Green Material Utilization

- Mr. Kun Chen highlighted the strategic significance of product decarbonization in achieving global climate objectives. He emphasized the strategic role of regulatory frameworks, life cycle assessment (LCA) methodologies, and market-facing certifications in guiding manufacturers and stakeholders to reduce carbon emissions across supply chains. His presentation also outlined a structured roadmap for aligning business practices with evolving policies and for leveraging environmental declarations to substantiate sustainability claims.
- Mr. Chen underscored that decarbonization has become priority for industries worldwide, driven by converging global, financial, and consumer pressures. He noted that 92% of global GDP is now covered by economy-wide net-zero commitments, reflecting broad policy convergence toward climate action. He further emphasized that investors are recalibrating expectations, with 93% anticipating that climate risks will significantly influence investment performance in the next two to five years. According to Mr. Chen, consumer behavior mirrors this shift, as 10% of buyers express willingness to pay a premium for products with verified sustainability attributes. He highlighted the substantial economic stakes: climate-related damages are projected to reach USD 38 trillion annually by 2050, whereas global mitigation using current technologies is estimated at USD 6 trillion.
- Mr. Chen explained that a combination of regulatory mandates and policy incentives is accelerating the adoption of low-carbon materials across global markets. He pointed to the European Union's Carbon Border Adjustment Mechanism (CBAM), which will impose carbon tariffs on selected imported goods beginning in 2026, as well as the EU Battery Regulation and the Ecodesign for Sustainable Products Regulation (ESPR), which require Product Carbon Footprint (PCF) disclosures and digital product passports. He also noted that several U.S. states, including Colorado and Oregon, have introduced Environmental Product Declaration (EPD) requirements for public procurement, thereby mandating LCAs for key construction materials.

- Mr. Chen also highlighted the influence of incentive-based policies in shifting procurement practices. He cited the U.S. Buy Clean Initiative and the Inflation Reduction Act (IRA), which prioritize federal purchasing of low carbon steel, concrete, and glass. He further noted that the EU Corporate Sustainability Reporting Directive (CSRD) and the upcoming LEED v5 framework heighten the importance of Scope 3 emissions and embodied carbon metrics, encouraging companies to adopt LCA and PCF methodologies in their sustainability reporting and building design processes.
- Mr. Chen emphasized that Life Cycle Assessment (LCA) has become a foundational tool in guiding decarbonization within the built environment. He explained that LCA provides a standardized means of quantifying greenhouse gas (GHG) emissions across the entire product life cycle—from raw material extraction and manufacturing to use and end-of-life. He referenced international standards, including ISO 14040, ISO 14044, ISO 14067, and EN 15804+A2, which ensure methodological rigor, consistency, and credibility in environmental impact reporting.
- Mr. Chen outlined the LCA process, beginning with the systematic collection of mass and energy flow data from production sites and suppliers. He explained that this information forms the Life Cycle Inventory (LCI), which documents all inputs and outputs associated with each stage of the life cycle. Through the application of emission factors and environmental impact indicators, practitioners evaluate carbon “hot spots” and identify opportunities for improvement. Mr. Chen emphasized that these insights guide strategic decision-making, such as product redesign or material substitution, and form the basis for Environmental Product Declarations (EPDs) that enhance market transparency and support compliance with emerging regulatory and procurement requirements.
- Mr. Chen emphasized that understanding carbon intensity across sectors and materials is essential for formulating targeted decarbonization strategies. He explained that Life Cycle Assessment (LCA) data reveals considerable variation in upstream and downstream emissions across industries, thereby identifying priority areas for intervention.
- Mr. Chen outlined that sectors such as construction, packaging, food and beverage, and electronics exhibit distinct carbon profiles throughout their value chains.

According to him, these sectors hold significant potential for reducing embodied carbon through improved design, procurement practices, and material innovation.

- Material-Level Case Studies

    1. Cement and Concrete: Cement manufacturing accounts for approximately 77% of total emissions in the concrete lifecycle, making it a critical focus for low-carbon innovation and policy support.
    2. Consumer Electronics (iPhone 16 Plus): Apple achieved a 24 kg CO_2e reduction per unit by integrating recycled materials and renewable energy into its production processes, demonstrating the effectiveness of circular design and clean energy sourcing.
    3. Beverage Packaging: In economies with cleaner energy grids, aluminum cans and glass bottles outperform PET plastic in terms of carbon footprint. This underscores the importance of aligning material choices with domestic energy mixes to maximize decarbonization benefits.

- Mr. Chen further stressed that recycled content and embodied carbon reductions serve as strategic levers for decarbonization. He noted that framing material selection through these lenses enables evidence-based decision-making for policymakers, industry stakeholders, and sustainability planners.

- Mr. Chen highlighted that recycled materials deliver substantial reductions in both energy consumption and greenhouse gas emissions, as demonstrated by the following findings:

    1. Polyethylene Terephthalate (PET): Recycled PET achieves a 59% reduction in Global Warming Potential (GWP) compared to virgin resin.
    2. High-Density Polyethylene (HDPE) and Polypropylene (PP): Recycled variants emit approximately 30% of the GHGs associated with their virgin counterparts.

    These findings underscore the importance of integrating recycled content into procurement policies, product design, and certification frameworks to accelerate decarbonization across supply chains.

- Mr. Chen underscored that the design phase provides the greatest leverage for reducing embodied carbon in the built environment. He highlighted two key approaches:

    1. Build Nothing" and "Build Less" Strategies: Prioritizing adaptive reuse and maximizing existing assets can yield the highest carbon savings.
    2. Material Optimization and Efficient Construction: Selecting low-carbon materials and employing efficient construction technologies further reduce environmental impact.

    These strategies align with global climate targets and can be embedded into building codes, rating systems, and public procurement guidelines to drive systemic change.

- As sustainability regulations and market expectations evolve, organizations must adopt credible tools to communicate product-level environmental impacts. Mr. Chen explained that Environmental Product Declarations (EPDs) and Product Carbon Footprints (PCFs) are widely recognized frameworks that support transparency and verification, each serving different disclosure objectives.

- According to Mr. Chen, EPDs are well suited for sectors such as construction, where multi-impact transparency is necessary for certification schemes—including LEED and BREEAM—and for public procurement. PCFs, in contrast, provide a streamlined approach for carbon-specific claims, particularly beneficial for consumer goods and electronics where clarity and market speed are essential.

- Mr. Chen stated that governments and certification bodies can use both tools to:

    1. Standardize environmental reporting across industries.
    2. Incentivize low carbon procurement.
    3. Support Scope 3 emissions tracking.
    4. Align with global frameworks such as ISO, CSRD, and Buy Clean initiatives.

- Case Study: Owens Corning – Thermafiber® Mineral Wool Insulation

    Owens Corning's optimization of its Thermafiber® Mineral Wool Insulation demonstrates the tangible benefits of data-driven environmental performance:

    1. Achieved up to 53% reduction in Global Warming Potential (GWP).

2. Delivered measurable improvements across multiple impact categories, including acidification, eutrophication, and resource depletion.
3. Optimization outcomes were validated through UL Environmental Product Declaration (EPD) and Product Carbon Footprint (PCF) certifications, ensuring transparency and comparability.

- Mr. Chen concluded by emphasizing that this case exemplifies how manufacturers can leverage LCA insights to drive product innovation, meet procurement requirements, and align with broader sustainability targets. He stressed that data transparency, sector-specific analysis, and third-party certifications play a critical role in advancing product decarbonization while improving market competitiveness and meeting stakeholder expectations.

Prasetyoadi – Green Building Council Indonesia

Case Studies from the GBCI Context: Lessons Learned in Training and Material Certification Implementation

- Mr. Prasetyoadi delivered a comprehensive presentation highlighting key lessons learned from the Green Building Council Indonesia (GBCI) in implementing training programs and material certification within the green building framework. He emphasized the need for a transformative approach to the built environment through sustainable material use, circular economy principles, and context-based strategies. His session underscored the environmental impacts of construction materials, the urgency of decarbonizing existing buildings, and the importance of policy support, technological innovation, and community engagement in advancing regenerative development. Additionally, he stressed the value of international collaboration and the integration of local wisdom in promoting green building practices across Asia-Pacific economies.

1. The Built Environment's Carbon Footprint
    - Mr. Prasetyoadi highlighted that the built environment accounts for 40% of global CO_2 emissions—27% from building operations and 13% from embodied carbon associated with materials and construction activities.

- He noted that concrete, steel, and aluminum collectively contribute 23% of global emissions, reinforcing the need for material innovation and stronger policy interventions.

2. The Case for Circularity

   Mr. Prasetyoadi emphasized that a circular building maximizes resource efficiency and minimizes waste through:

   - Use of durable, recyclable, and non-toxic materials.
   - Design for adaptability, disassembly, and reuse.
   - Integration of LCA, LCC, and digital material passports.
   - Application of the “Design for X” framework promotes long life, loose fit, refurbishment, and service sharing across a building’s lifespan.

3. Strategic Goals for 2030 and 2050

   - For 2030, Mr. Prasetyoadi outlined targets including zero waste to landfill and net-zero whole-life resource depletion.
   - For 2050, he projected a vision of fully regenerative built environments that restore ecosystems and support circular economic systems.
   - Locality and International Cooperation.

4. Key Locality Considerations:

   - Prioritizing locally sourced materials to reduce transport emissions and strengthen regional economies.
   - Ensuring material choices are climate-adaptive and suitable for local environmental conditions.
   - Preserving cultural identity through traditional materials and construction techniques.
   - Strengthening local waste management and recycling infrastructure.
   - International Collaboration Opportunities:
     - Knowledge exchange on sustainable materials.

- Technology transfer for green manufacturing.
- Policy harmonization and mutual recognition.
- Market access for local green materials.

5. Green Material Categories and Innovations

   Mr. Prasetyoadi also highlighted a range of innovative material categories, including:

   - Non-conventional materials: Rammed earth, bamboo, straw bale, recycled plastic, and adobe.
   - Conventional alternatives: Fiber-reinforced mortar, recycled cotton, polyurethane foam.
   - Modular and prefabricated systems: Improve efficiency, reduce waste, and lower embodied carbon.

6. Green Building Council Indonesia (GBCI) Framework

   Mr. Prasetyoadi elaborated on the GBCI's *Greenship Rating Tools*, particularly the Material Resources & Cycle (MRC) credits, which serve as a benchmark for sustainable material use and circularity in building projects.

7. Greenship Rating Tools – Material Resources & Cycle (MRC) Credits:

Credit	**Focus Area**	**Key Criteria**
MRC 1	Reuse of building materials	≥15–30% reused materials
MRC 2	Environmentally friendly processes	Use of recycled, renewable, and eco-labelled materials
MRC 3	Ozone-friendly materials	No ODP substances in fire suppression or cleaning
MRC 4	Certified timber	Legal and sustainably sourced wood

Credit	Focus Area	Key Criteria
MRC 5	Prefabricated materials	≥30% modular/prefab components
MRC 6	Local/domestic materials	≥50–80% sourced within 1,000 km or domestically
MRC 7	Life cycle assessment	Use of LCA tools to quantify material impacts
MRC 8	Green cleaning practices	Non-toxic, eco-certified cleaning agents
MRC 9	Green procurement	Tenant and manager commitment to green purchasing

8. Health, Safety, and Indoor Air Quality

   Mr. Prasetyoadi emphasized the importance of ensuring occupant well-being using healthier materials and advanced indoor environmental quality strategies. He highlighted:

   - The selection of low-VOC paints, formaldehyde-free adhesives, mercury-free lighting, and materials free from persistent bioaccumulative toxins (PBTs).
   - The need for advanced indoor air quality assessments and the use of UVGI (Ultraviolet Germicidal Irradiation) systems to maintain optimal air quality after construction and during occupancy.

9. Resource Scarcity and Regenerative Materials

   In addressing long-term sustainability challenges, Mr. Prasetyoadi underscored the growing scarcity of key construction resources:

   - Cement and marble face depletion risks within 200 years; sand within 70 years.

- Advocates for regenerative materials that sequester carbon, restore ecosystems, and renew naturally.
- Encourages rethinking extractive practices and embracing nature-based, locally sourced solutions.

Mr. Prasetyoadi concluded his presentation with a compelling vision for a more sustainable and regenerative built environment; one grounded in circularity, local wisdom, and strengthened international collaboration. He emphasized that through the systematic adoption of sustainable material practices, the implementation of robust policy frameworks, and the active participation of communities and stakeholders, the construction sector can play a pivotal role in strengthening climate resilience, ensuring long-term resource security, and advancing broader environmental stewardship objectives.

DAY III

Field Trip

Learning How Green Materials are Implemented in a Building

ECOLABO8

- The field visit began with an introduction to ECOLLABO8, a Bali-based company specializing in post-consumer recycled plastic processing. Their product line includes weather-resistant panels ("ecotiles"), furniture, and architectural elements designed for large-scale interior and exterior projects. ECOLLABO8 operates primarily in Bali, with plans to expand by establishing a new facility in Bekasi to serve the Jabodetabek economy.
- ECOLLABO8 follows a B2B/project-based business model and does not engage in retail sales. They emphasized their commitment to sustainability by using approximately 90% recycled content in their products, exceeding the typical 50% benchmark found in many eco-certifications. Instead of pursuing external "eco/green" labels, ECOLLABO8 relies on stricter internal standards and technical performance validation through compressive strength testing.

- During the Q&A session, participants discussed certification issues, production capacity, and expansion plans. ECOLLABO8 confirmed that its Bali facility is sufficient and need not be expanded; future growth will focus on the Bekasi plant to improve waste processing and better serve urban markets. Their commercial strategy prioritizes large-scale projects to ensure consistent quality, volume, and after-sales service.
- Overall, the visit provided a comprehensive overview of ECOLLABO8's background, product portfolio, operational sites, and strategic direction. It highlighted the company's high internal standards, technical quality assurance, and measured expansion approach to support sustainable material management in densely populated areas.

ECOCRETE

- Ecocrete Indonesia is a pioneering green technology company specializing in low-carbon and sustainable concrete solutions. Established in 2016, the company is headquartered in Bali and operates with a mission to revolutionize Indonesia's construction industry through the use of eco-efficient materials, circular economy principles, and sustainable production methods.
- Ecocrete's product line focuses on eco-concrete and green construction materials that minimize the environmental impact traditionally associated with cement-based products. The company's innovative approach centers on reducing CO_2 emissions, recycling industrial waste, and optimizing resource efficiency in concrete production. By substituting traditional Portland cement with supplementary cementitious materials (SCMs) such as fly ash, ground granulated blast furnace slag (GGBFS), and rice husk ash, Ecocrete successfully reduces the carbon footprint of its products while maintaining strength and durability standards in line with SNI and ASTM requirements.
- The visit provided first-hand exposure to innovative, industry-driven green material practices and their integration into the Indonesian construction ecosystem. The following insights emerged from the discussions:
    - Material Innovation as a Driver of Decarbonization: Ecocrete's operations demonstrate how technological substitution in material composition can directly support national carbon reduction targets.

- Standardization Linkage: The company's adherence to SNI and international environmental standards underscores the importance of harmonized quality infrastructure in advancing green material adoption.
- Market Readiness: Increasing awareness among developers and contractors, particularly those pursuing GBCI or LEED certifications, has created strong market incentives for green concrete products.
- Challenges and Policy Support Needs: The company identified barriers related to supply consistency of industrial by-products and limited fiscal or policy incentives for low-carbon materials. Greater collaboration between regulators, standard bodies, and industry is essential to scale up adoption.

BALAI DIKLAT KEUANGAN DENPASAR

- The *Balai Diklat Keuangan* (BDK) Denpasar campus was awarded the Green Building Certificate (Bangunan Gedung Hijau – BGH) from the Ministry of Public Works and Housing (PUPR) in May 2024. The certification applies to multiple buildings on the campus, including:

  1. Dormitory Buildings I & II
  2. Training/Classroom Building
  3. Office Building
  4. Musholla (Prayer Room)

  All buildings achieved a "Madya" (Intermediate) rating under the BGH technical planning category.

- The BGH rating system evaluates buildings based on seven criteria:

Criteria	Weight (%)	Achieved Points
Energy Efficiency	28%	35
Site Management	23%	25
Water Efficiency	13%	10
Indoor Air Quality	12%	14
Environmentally Friendly Materials	13%	18
Water Waste Management	7%	7
Solid Waste Management	4%	5
Total	100%	114/165

- BDK Denpasar demonstrated strong performance in this category by:
  1. Using paints and coatings free of hazardous substances.
  2. Selecting wood/bamboo materials without toxic adhesives.
  3. Applying rust-resistant coatings on metals.
  4. Sourcing concrete and wall materials locally (within 1000 km).
  5. Using certified eco-labeled products (e.g., ISO 14001, Singapore Green Label).
  6. Incorporating recycled and renewable materials in ceilings and walls.
  7. Ensuring domestic component content (TKDN) of at least 40%.
- The campus implements several eco-friendly practices:
  1. Waste Management: Segregation of organic, inorganic, and recyclable waste; composting initiatives.
  2. Energy Efficiency: Use of motion sensor lighting, solar-powered lamps, and natural lighting optimization.
  3. Water Efficiency: Rainwater harvesting systems for toilet flushing; wastewater from handwashing is reused for garden irrigation.

Closing Remarks

Wahyu Purbowarsito - Deputy for Accreditation, National Standardization Agency of Indonesia

The Advance of Green Materials for Resilient and Sustainable Economy

- Mr. Wahyu Purbowarsito expressed his appreciation to all participants for their constructive insights, active engagement, and strong collaboration throughout the sessions in Bali. He emphasized that the collective effort demonstrated during the workshop reflects a shared commitment to transforming the potential of green materials into tangible, scalable implementation.
- Mr. Wahyu reflected on several core challenges raised during the discussions, including uneven levels of awareness, fragmented standards, and lengthy verification processes that continue to constrain market adoption of green materials. Nevertheless, he observed a growing sense of optimism across the region, noting that relevant technologies are rapidly advancing, business cases are becoming more compelling, and APEC economies increasingly align in their pursuit of cleaner and more resilient construction practices.
- Mr. Wahyu highlighted that trust and alignment in standards are central to progress. When performance data and test reports are credible and comparable across borders, greener options become less risky and more attractive to markets. Harmonizing standards without erasing domestic context enables smoother trade, faster verification, and greater confidence among designers, builders, and regulators.
- He emphasized that quality infrastructure including robust systems for standards, testing, accreditation, and certification is essential for this trust. Reliable measurements and credible conformity assessments help speed up permits, reduce disputes, and ensure safety. As he put it: “We cannot decarbonize what we cannot measure, and we cannot scale what we do not trust.”
- He also highlighted capacity building as a critical pillar in the transition. Practical, hands-on training is needed to equip architects, engineers, contractors, SMEs, and regulators with an understanding of lifecycle assessment, documentation requirements, and performance-based standards. Strengthening these competencies will enable professionals to make informed, sustainability-oriented decisions throughout the value

chain.

- On the policy front, Mr. Wahyu urged governments to lead through green public procurement, measurable incentives, and interoperable digital compliance systems that simplify processes without lowering standards. Carefully piloted cross-border acceptance of test reports can also speed up market entry for verified products.
- He concluded that change would come not from declarations but from verified action when each actor in the system makes credible, evidence-based decisions that multiply across the economy.
- Summarizing the key takeaways, Mr. Wahyu reiterated that the limited adoption of green materials in developing economies is largely driven by persistent financing constraints and the need for broader shifts in mindset across stakeholders. He emphasized that governments must strengthen quality infrastructure, enhance awareness among both the public and industry actors, and establish effective incentives and financial mechanisms to support innovation. He also highlighted that sustained collaboration, continuous capacity building, and systematic knowledge sharing, particularly from more advanced APEC economies, are essential to accelerating progress in this sector.
- In closing, he conveyed his appreciation to all participants and concluded with a compelling message:

  “From Bali, let us carry a simple pledge, measure what matters, certify what performs, procure what delivers, and scale what lasts. When trust in standards and measurements takes root, green will no longer be just a label, but a market reality embedded in our buildings, policies, and skylines.”

II. Briefings on Discussions at the Workshop

Q&A / Discussion

Session 1: Current Trends and Challenges in Green Material Utilization.

Ms. Tiara Fitrida – PT. Charlie Sierra Sierra Indonesia.

A Deep Dive into the Current Landscape of Green Material Application and its Associated Challenges

- During the Q&A session, one of the participants asked Ms. Tiara a question regarding the balance between innovation and consistency in the private sector's approach toward implementing green building initiatives. The participant noted that while some private companies maintain consistency in their established methods, others are more focused on innovation and adaptation. They then asked for Ms. Tiara's opinion on which approach, innovation or consistency, would be more effective for the private sector in advancing green construction practices.

  In response, Ms. Tiara thanked the participant for the question and shared her perspective that innovation should be highly appreciated, as it represents the starting point for progress. She emphasized that innovators are not only thinkers but also executors who drive real change. According to her, policymakers should focus on creating clear guidelines and frameworks that align with the market's direction and the innovators' goals. She suggested that both policymakers and innovators have their respective pathways, and the key is to find common ground where these paths can meet. By doing so, she concluded, both sides can grow together toward achieving the shared goal of sustainable development across the APEC economy.

- During the Q&A session, Mr. Muhammad Solikin from Universitas Muhammadiyah Surakarta shared his appreciation for Ms. Tiara's presentation, noting that it was both interesting and thought-provoking. He reflected on the responsibility of civil engineers in contributing to carbon emissions, around 40 percent globally, and expressed that the forum served as a valuable platform to raise awareness about this issue. He then asked Ms. Tiara for her perspective on the future balance between conventional and green materials. Specifically, he wanted to know whether it would be possible to fully replace conventional materials with green alternatives, or what the ideal target or ratio between

the two should be in the future.

In response, Ms. Tiara thanked Mr. Solikin for his insightful question and confirmed that civil engineers indeed play a significant role in addressing carbon emissions. She then referred to one of her slides, specifically slide number 12, titled “Transitioning Building Materials to a Low-Carbon Future.” She explained that the projection from 2020 to 2060 shows a clear trajectory toward increasing the share of green materials.

According to the data, structural materials currently make up more than 50 percent of total building materials, but by 2060, this figure is expected to decrease to around 25–30 percent. She highlighted the growing use of recycled steel, designed-for-Summary of the Workshop.

Session 2: Innovation in Sustainable Building Materials

Phuong Tran – Viet Nam Institute for Building Science and Technology, Ministry of Construction, Viet Nam

Building Green Futures: Breakthroughs in Sustainable Material Technology

- One of the participants began by noting that, similar to economies like Viet Nam and Indonesia, many research-based green materials are emerging from laboratories but face challenges in moving toward market adoption. The participant asked how Viet Nam’s policy and strategy address this issue, and what roadmap the economy follows to support the transition from research to large-scale utilization of green materials.

  Mr. Tran responded by explaining that as a developing economy, Viet Nam aims to balance rapid economic growth with sustainable development, which is why green materials have become an economy-wide focus. He outlined three key strategic directions:

  - Establishing a Clear Policy Framework – Viet Nam has environmental laws and regulations, and by 2030, the government plans to introduce around 100 new standards specifically for green materials.

- International Collaboration – Viet Nam actively cooperates with global organizations such as IFC, the World Green Building Council, and GlobalABC to develop and implement green building certification systems. As a result, the number of certified green buildings in Viet Nam has doubled from 300 to 700 projects between 2024 and 2025.
- Investment in Technology and Capacity Building – Mr. Tran explained that Viet Nam's institutes play a crucial role in creating standards for new technologies. For instance, when new timber technologies from Japan were introduced, his institute facilitated pilot projects, developed standards, and conducted workshops to train engineers on their use.
- He also shared a case study of collaboration with YTL from Malaysia to develop green cement using renewable energy and industrial waste, which helped reduce emissions by 50% in five years.

However, Mr. Tran emphasized that Viet Nam still faces two major challenges: limited funding and the need to raise public awareness. He noted that unlike in economies such as Australia, where most people understand the concept of green building, only about 10% of Vietnamese citizens are familiar with it. To address this, Viet Nam has increased its efforts to communicate and educate the public through conferences and awareness campaigns.

In 2023, only two or three conferences on green materials were held annually, but by 2024–2025, this number is expected to increase to at least five per year. Mr. Tran concluded that effective communication and education are essential to connect government initiatives, investors, developers, and the public, creating a stronger domestic movement toward a green economy.

- Another participant followed up by asking about the standards used in developing Viet Nam's green building framework. Specifically, they wanted to know whether Viet Nam's domestic standards are based on international references or developed independently.

  Mr. Tran explained that Viet Nam generally adopts international standards, particularly from Europe, but with necessary local modifications to suit Viet Nam's conditions. For example, when importing timber technology from Japan, adjustments must be made for local climate factors such as humidity and temperature.

He also mentioned that Viet Nam plans to introduce LCA (Life Cycle Assessment) and EPD (Environmental Product Declaration) standards in the coming years. However, since Viet Nam lacks advanced recycling technologies compared to Western economies, certain parts of these standards, especially those concerning material recycling, must be adapted to local capabilities. He clarified that Viet Nam never develops standards entirely from scratch, but instead adopts and revises existing global standards to create effective local versions.

- Mr. John Steven Magboo from the Philippines then asked which low-carbon material innovations Mr. Tran believed hold the greatest potential to achieve large-scale impact across APEC economies. He also inquired if there were any emerging or “moonshot” technologies that could redefine the path toward full decarbonization of construction materials.

  In response, Mr. Tran explained that there are three main strategies to reduce embodied carbon: avoid, reduce, and replace with “avoid” being the most effective. From a material standpoint, he highlighted that the use of lightweight materials has significant potential to lower emissions.

  He gave an example: when using traditional brick walls, the weight is about 2,000 kg per square meter, but with new drywall systems using steel frames and gypsum boards, the weight can be reduced by up to 70%. This reduction not only minimizes the structural load and foundation requirements but also lowers transportation energy needs.

  Mr. Tran further predicted that in the long term, perhaps within the next 30 to 40 years, timber could gradually replace cement as a dominant construction material due to its renewable nature, lightweight properties, and resilience against natural forces like earthquakes, storms, and fire. He emphasized that future materials should meet three criteria:

  - Be renewable and widely available.
  - Be lightweight.
  - Be produced with low energy consumption.
  - He later clarified that, in the short term, cement reduction will mainly rely on lower clinker ratios and the use of Supplementary Cementitious Materials (SCM) that

require less energy to produce.

- Finally, a participant asked about Viet Nam's regulatory approach, particularly regarding performance-based specifications in construction standards. Mr. Tran explained that Viet Nam has recently started implementing performance-based standards, such as in fire safety regulations. Rather than prescribing specific materials, the regulation now defines performance criteria, for instance, how long a material must resist fire and engineers can choose materials that meet these criteria through calculation and testing.

  He added that Viet Nam is gradually transitioning from ratio-based or prescriptive standards (previously influenced by Chinese codes) to European-style performance-based systems. This shift, he said, will allow for greater flexibility and innovation in material development and design, supporting Viet Nam's broader move toward sustainable construction.

Putu Nadi Astuti – Directorate of Cement, Ceramic, and Non-Metallic Mineral Processing Industries, Ministry of Industry of Indonesia

Challenges and Opportunities in Policy Implementations of Green Materials

- The first question came from Mr. John Steven Magboo from the Bureau of the Philippines Standards, who asked about Indonesia's green industry certification procedure. He wanted to understand which ministry is responsible, how different ministries coordinate (such as those handling energy, environment, and product standards), who conducts the audits, and what the validity period of the certification is, including whether there are surveillance audits.

  Ms. Putu explained that the certification process is handled under the Ministry of Industry, using what is called the Green Industry Standard (Standar Industri Hijau / SIH). This framework is similar to Indonesia's National Standard (SNI), but it focuses on efficiency in resource and energy use, environmental performance, and community benefits. The certification is voluntary, not mandatory, and is conducted by accredited certification bodies authorized by the Ministry of Industry. These bodies have the competence to perform audits and issue certificates. For now, over 30 companies in sectors such as cement, ceramics, and glass have been certified.

- Mr. Magboo then followed up, referring to a slide in the presentation that showed a target number of certified plants, for example, 14 in the cement sector. He asked whether these numbers represent certifications under the voluntary SIH scheme, or if they relate to mandatory product standards like those for cement or ceramic tiles.

  Ms. Putu clarified that the numbers shown refer to voluntary certifications under the Green Industry Standard, not to mandatory product standards. She emphasized that, at present, no product category is required to comply with SIH; it remains entirely voluntary. However, she noted that in the future, as the green industry standard becomes an important tool to measure energy efficiency and decarbonization progress, it might eventually become mandatory if deemed necessary.

- Mr. Magboo asked a final follow-up question about whether the Ministry of Industry plans to make the Green Industry Standard mandatory in the future.

  Ms. Putu responded that the possibility exists, as the green industry standard is one of the key strategies in Indonesia's industrial decarbonization roadmap. It helps the government monitor, evaluate, and track industrial energy use and emissions. While there is no current timeline for making it mandatory, the potential remains open, depending on Indonesia's policy directions for emission reduction and green growth.

- Another participant, Ms. Tiara, asked a question related to decarbonization data. She wanted to know whether there is a reference or catalog from the Ministry of Industry that allows users to compare the carbon footprint of different materials, for instance, comparing Indonesian marble with imported green-certified tiles from China to determine which one is more environmentally friendly.

  Ms. Putu explained that such a detailed catalog does not yet exist. However, there has been progress in developing sectoral decarbonization roadmaps, starting with high-emission industries such as cement, ceramics, and concrete. The Ministry previously issued a roadmap for cement emission reduction in 2012, and since then, the industry has begun reporting its annual carbon emission data through the National Industry Information System. These data form the baseline for emission reduction targets up to 2050. Efforts already underway include reducing the clinker factor, using alternative fuels such as RDF and biomass, and in the future, exploring carbon capture technologies (CCS/CCUS) once the technology becomes more affordable.

- A final question came from another participant who asked how the government encourages industries to adopt the Green Industry Standard if it is still voluntary.

  Ms. Putu replied that the most effective way would eventually be through mandatory regulation, similar to how Indonesia enforces mandatory SNI product standards. However, even without a mandate, adoption has been encouraging, more than 50% of cement producers have already been certified voluntarily. The awareness and market demand for green products have driven companies to pursue certification, recognizing the business benefits of improved efficiency and environmental performance.

  The moderator added that this approach is similar with Turkey's halal certification system, where accreditation is mandatory but product certification itself remains voluntary. The key, he said, lies in raising consumer awareness so that market demand naturally encourages compliance.

Session 3: The Latest Development in Green Material Technologies.

Presentation by Ms. Shirley Dewi – IAPMO R&T USA

Cutting-Edge and Sustainable building Material Technologies in the USA and Study Cases

- A participant raised a question regarding the challenges contractors face in adopting innovative construction products in Indonesia. The participant explained that even though many innovative materials and technologies are available in the market, contractors often hesitate to use them because government tenders and project contracts still refer to outdated standards. This creates uncertainty and risk when attempting to apply new solutions.

  Ms. Shirley acknowledged the concern and clarified that while she could not speak directly on Indonesian government regulations, she shared how innovation and regulation interact in the United States as a point of comparison.

  She explained that in the US, the federal government sets general or minimum requirements, but these regulations are not overly prescriptive, allowing room for

innovation. As long a product meets or exceeds the minimum safety and performance criteria, innovative solutions are permitted. She noted that it is common for innovation to move faster than regulation, and a flexible regulatory approach helps support technological advancement.

Ms. Shirley also emphasized the importance of proactive collaboration between manufacturers, contractors, and regulators. She explained that in the US, many standards and building codes are developed through industry participation, often driven by manufacturers and practitioners themselves. She highlighted that organizations such as UL and the International Association of Mechanical Officials (IAMO) host annual conferences and technical committee meetings, where industry players, including manufacturers, contractors, and other stakeholders, are invited to contribute.

She concluded by stating that standards are developed for the public good, and therefore, industry involvement is essential to ensure they remain relevant, practical, and reflective of current technological capabilities.

- A participant asked about how the US government or industry provides preferences to contractors that supply green, sustainable, or locally made products, similar with Indonesia's TKDN (local content) policy.

  Ms. Shirley explained that in the United States, the process is quite similar to other economies, government contracts and tenders are based on clear specifications. When bidding for a project, contractors must meet the listed requirements, which may include sustainability standards or environmental certifications, depending on the project's nature. While the US does not have a direct equivalent to TKDN, certain sustainability requirements are automatically integrated into public projects, especially in specific states. For instance, in California, any government building project above a certain value must comply with the "CalGreen" standard, which mandates the use of products that meet specific environmental and performance criteria, including alignment with LEED (Leadership in Energy and Environmental Design) or other green certification frameworks.

  She added that some projects explicitly specify sustainability criteria within their tenders, which naturally favors contractors who can meet those green requirements. Ms. Shirley also mentioned that in recent years, particularly following political developments such as

the “US First” policy under President Trump, there has been an increasing emphasis on prioritizing domestically produced goods in public contracts.

She concluded by clarifying that these policies are embedded within the contract specifications, not standalone incentives, and that contractors must align their offerings with the defined sustainability and sourcing requirements to qualify for government projects.

- Mr. Solikin from Muhammadiyah Surakarta University asked two questions. First, he wanted to know whether there is any labeling scheme for certified green products, to help consumers easily identify eco-friendly materials. Second, he asked about the main criteria used in green building certification, whether it is based on the amounts of reused materials, or on reduced carbon emissions.

  Ms. Shirley clarified that for the first question, certified green products indeed carry special labeling or marks to indicate their certification status. In Indonesia, for instance, products certified by the Ministry of Environment are granted an eco-label that helps the public easily recognize environmentally friendly products. There is also an independent certification scheme, such as Green Label Indonesia, which evaluates products against specific sustainability criteria and assigns ratings such as Platinum, Gold, and others, depending on their level of compliance.

  She added that internationally, similar labeling schemes exist. For example, in the United States, certified products can carry the UL GREENGUARD mark, which signifies that the product has been tested and verified to meet environmental and health-related performance standards. These labeling systems are designed to give consumers confidence that the product has been tested by a credible third party and meets recognized sustainability benchmarks.

  Regarding the second question about green building certification, Ms. Shirley explained that the evaluation covers multiple aspects, not just material reuse. Green building rating systems generally apply a point-based framework that considers various factors, such as the use of recycled or certified green materials, energy and water efficiency, and carbon emission reductions.

In summary, both eco-labeling for products and green building certifications aim to promote transparency and accountability, helping consumers and builders make more informed and sustainable choices.

- A participant asked about data management and monitoring systems for sustainability performance in buildings in the United States, particularly concerning energy and water efficiency. He wanted to know whether there is a common data environment or government platform used to collect and analyze these data and whether such information is used to support policy development or evaluation of building performance.

  Ms. Shirley explained that the US approach differs from many other economies, especially in Asia, because a large portion of sustainability research and data collection is conducted by private organizations in partnership with government agencies.

  She noted that the US Environmental Protection Agency (EPA), equivalent to Indonesia's Ministry of Environment, plays a leading role in sustainability programs. The EPA collaborates with private research institutions and standard-developing organizations, such as UL Solutions and IAPMO, to gather data and develop standards before introducing new sustainability-related regulations.

  For example, the EPA's "WaterSense" program focuses on water efficiency. To establish standards under this initiative, the agency first commissions research and data collection through partnerships with technical bodies like UL or IAPMO. These organizations collect and analyze performance data, which the EPA then uses to define benchmarks and create regulatory baselines. MS. Shirley added that while the US government occasionally conducts its own studies, for instance, through the National Institute of Standards and Technology (NIST), much of the research is outsourced to the private sector to speed up innovation and reduce bureaucratic delays.

  Importantly, she emphasized that most of the resulting data and reports are publicly accessible, in line with the US principle of transparency. Interested parties, including developers, researchers, or policymakers, can freely access sustainability studies and datasets through the EPA or NIST websites, which serve as open references for future standards and building performance analysis.

- A participant asked for clarification about the criteria used in certification schemes in the US, particularly concerning voluntary and mandatory schemes, and whether there are

specific requirements for the accreditation of conformity assessment bodies involved in material testing or product certification.

The speaker explained that in the United States, the criteria depend on the type of product or scheme, but there is a strong emphasis on third-party conformity assessment. Products must typically be tested or certified by an accredited body, in accordance with internationally recognized standards such as:

1. ISO/IEC 17065 – for product certification bodies, and
2. ISO/IEC 17025 – for testing laboratories.

She emphasized that accreditation is taken very seriously in the US, even for voluntary schemes, to ensure the credibility and trustworthiness of the certification process. Although not all schemes are mandatory, the market and consumer awareness play a strong role, industries and consumers in the US tend to demand accredited certification as a sign of reliability and compliance. She also noted that, unlike some developing systems where enforcement drives compliance, in the US the industry and consumers themselves "self-regulate" by preferring certified and accredited products, making the process industry-driven rather than government-enforced.

Kun Chen – UL Solutions

Monitoring and Enforcement within Policy and Regulatory Frameworks for Promoting Green Material Utilization

- During the Q&A session, a participant representing a group of contractors raised two questions to Mr. Kun Chen from UL Solutions. The participant first asked about the main challenges in collecting data needed to conduct Life Cycle Assessment (LCA) in construction projects. The second question concerned whether there are any incentives or recognition systems available for contractors who implement LCA in their business activities.

  In response, Mr. Kun Chen explained that conducting an LCA for the construction phase of a building is a highly complex and detailed process. He noted that LCAs generally cover the entire life cycle of a building, not just the construction phase. One of the key challenges, he said, lies in the data collection process, which requires comprehensive

information on a wide range of factors, including all raw materials, energy consumption (electricity and fuel), equipment use, human activities, and waste generation (both solid and liquid). Because so many variables are involved, the process demands significant time, planning, and coordination. Moreover, he mentioned that standardized methodologies for assessing the construction phase are still lacking in many cases, adding to the complexity.

Addressing a follow-up question about digital tools that can assist with LCA calculations, Mr. Chen noted that there is currently no specialized software designed exclusively for construction or building materials. However, there are several widely used generic LCA tools, such as SimaPro, GaBi, and One Click LCA, which can help practitioners estimate carbon emissions and other environmental impacts. These tools work by combining the total quantities of materials and energy used with their corresponding emission factors from established databases to produce a rough estimate of the overall environmental footprint.

Regarding incentives for contractors, Mr. Chen stated that, as far as he is aware, there are no direct financial incentives or government-backed rewards specifically for implementing LCAs. However, in some cases, especially for large-scale or high-profile projects such as shopping malls or government buildings developers may require all contractors and suppliers to provide Environmental Product Declarations (EPDs) or carbon footprint reports as part of the project's sustainability commitments. While not offering monetary benefits, this requirement can act as an indirect incentive, since participation in such projects may depend on the ability to meet these sustainability standards. Mr. Chen concluded by emphasizing that although the LCA process is demanding, its implementation is becoming increasingly important as the construction industry moves toward transparency, sustainability, and low-carbon practices.

- During the Q&A session, a participant asked Mr. Kun Chen to elaborate on whether Life Cycle Assessment (LCA) should be conducted only for a single construction project or should include the entire upstream and downstream supply chain.

  In response, Mr. Chen clarified that while in theory, an ideal LCA should cover the full life cycle, from raw material extraction (upstream) to the construction, operation, and end-of-

life stages (downstream), in practice, this is very difficult to achieve, especially in the construction industry.

He explained that contractors or developers usually have limited control over the supply chain, since many materials, such as ceramics, cement, or steel, are often imported from various economies (for example, tiles from China or steel from Japan). Because these materials pass through multiple layers of distributors, importers, or exporters, it is impractical to obtain detailed, real data from each supplier or manufacturer.

Therefore, Mr. Chen suggested that for most projects, the practical approach is to calculate the total quantity of key materials used (such as steel, cement, ceramics, etc.) and then apply emission factors from recognized databases to estimate the overall environmental impact. This method, while less precise, makes the process more manageable and still provides a useful approximation for sustainability assessment.

He also highlighted that in a perfect system, each supplier, especially manufacturers of raw materials would be responsible for calculating the carbon footprint or Environmental Product Declaration (EPD) of their products and passing this information down the supply chain. In this way, downstream companies could build their own LCA models based on verified upstream data. However, he acknowledged that this system is not yet fully implemented globally, as it remains complex, costly, and inconsistent across industries.

Mr. Chen noted that the European Union (EU) has started to take significant steps toward addressing this issue through new regulations. For example, under the EU Battery Regulation, manufacturers are required to calculate not only the Product Carbon Footprint (PCF) for the entire battery pack but also for key raw materials such as anodes, electrolytes, and metals (like lithium and iron). These regulations aim to encourage direct data reporting rather than relying solely on databases.

He concluded by emphasizing that although this kind of comprehensive data sharing is still far from full implementation, the EU's approach sets a strong example for how governments and industries can collaborate to make LCA data more transparent, accurate, and traceable across the supply chain.

- A participant asked whether Life Cycle Assessment (LCA) is mandatory for industries or companies under government regulations.

Mr. Kun Chen explained that in most cases, LCA is not yet mandatory. It generally serves as an additional or optional requirement, rather than a legal obligation. However, conducting an LCA or having an Environmental Product Declaration (EPD) can offer competitive advantages, especially during project bidding processes.

He mentioned that in some tenders, products that already have an EPD are more likely to be preferred by clients or evaluators, as it demonstrates the company's commitment to sustainability and transparency.

In certain cases, however, EPD requirements are mandatory. Mr. Chen cited an example from Italy, where some government-related projects, such as those involving the Italian state energy company, require suppliers to have an EPD certified specifically by EPD Italy. Without such certification, companies are not eligible to participate in the bidding process.

Because of these kinds of regulations and requirements in European markets, many manufacturers in China and other economies that supply materials or components to Europe have started to obtain EPD certifications proactively.

Mr. Chen concluded by noting that although LCA and EPD requirements are not universally mandatory yet, the trend is clearly moving toward stricter adoption, especially in economies where sustainability and carbon footprint disclosure are becoming essential for market access and public tenders.

- A participant asked which industries should be prioritized in adopting Life Cycle Assessment (LCA) and Environmental Life Cycle Assessment (ELCA) practices.

  Mr. Kun Chen responded that, based on his experience, the construction industry is the most suitable and urgent sector to prioritize for LCA adoption. He explained that construction material suppliers, especially those providing raw materials to the European Union (EU) and North American markets, are already facing growing pressure to comply with sustainability standards.

  He noted that in the United States, there are federal and state-level regulations and incentives encouraging companies to adopt LCA and obtain Environmental Product Declarations (EPD). Similarly, in both the EU and US, many green building certification

systems, such as LEED and BREEAM, require or strongly encourage the use of materials backed by verified EPDs.

Even sectors like the hospitality industry, particularly hotels, are increasingly required to meet green building standards, sometimes targeting platinum-level certifications. These sustainability requirements are transmitted down the supply chain, compelling manufacturers to align with LCA and EPD standards.

Mr. Chen added that because wealthier economies are willing to pay a premium for sustainable materials, this creates strong financial incentives for manufacturers. especially those in China; Indonesia; and Viet Nam, to produce construction materials that comply with international environmental requirements.

He concluded that the construction industry not only has the largest environmental footprint, but also the strongest market-driven motivation to adopt LCA and EPD practices due to regulatory expectations and export opportunities.

Prasetyoadi – Green Building Council Indonesia

Case Studies from the GBCI Context: Lessons Learned in Training and Material Certification Implementation

- A participant asked about the challenges in convincing consumers or project owners to adopt sustainable or green building materials, based on the speaker's experience in real projects.

  The speaker shared a practical example from their involvement in a construction project within the Nusantara (New Capital City of Indonesia). The project included several buildings, one of which was a mosque, considered a manageable pilot for testing alternative materials. He explained that three construction options were proposed:

  1. Conventional concrete, which requires large quantities of water and sand materials that are scarce and would need to be imported.
  2. Steel structure, which offers faster construction and reduces dependency on water and sand.

3. Engineered timber, sourced sustainably from old palm plantations and fallen trees, not from natural forests.

Despite presenting the sustainable advantages, the contractor ultimately rejected the alternatives and returned to the conventional concrete method. The speaker identified the main barriers as:

1. Mindset and resistance to change, as many stakeholders remain hesitant to adopt new materials or technologies.
2. Capacity and confidence, since both government and private sectors often worry about project schedules, budget control, and construction risks when using unfamiliar methods.

He concluded that the transition toward sustainable construction in Indonesia requires not only technical innovation, but also education, mindset transformation, and capacity building among project stakeholders.

- A participant asked whether the challenges discussed were mainly from the customer's perspective, and how the speaker managed to gain support from various stakeholders in implementing green building materials.

  The speaker acknowledged that cost perception remains one of the main barriers to adopting green materials. He emphasized that many still consider green materials as expensive, but this perception only holds true in the short term. To illustrate this, he compared the situation with the introduction of LED lighting: "When LED lamps first came to the market, they were three to five times more expensive. But now, they are widely used because they save energy, consume fewer resources, and their price has become almost equal to conventional lamps. The old incandescent lamps are now nearly extinct." He believes that green materials will follow the same trajectory, as adoption increases, costs will go down and their use will become standard practice.

  The speaker also stressed the importance of promoting local wisdom and local materials. Integrating locally sourced resources not only supports sustainability but also reduces dependency on imported materials. He concluded that the future of green materials is promising, provide that stakeholders continue to expand the market, educate consumers, and support innovation from both local industries and global partners.

- The moderator invited the speaker to share insights on what it takes to make green materials a mandatory standard in construction projects, noting that many contractors feel they are working alone in promoting the use of sustainable materials.

  The speaker explained that the journey toward making green materials mandatory has been a gradual process driven by a combination of corporate commitment, international influence, and government collaboration.

  When the Green Building Council was first established in 2008, its founding members were primarily corporate entities that had already shown interest in sustainability. The initial demand for green materials and sustainable practices introduced by multinational corporations (MNCs) operating in Indonesia, who were motivated by global environmental standards and corporate sustainability commitments.

  Over time, government involvement grew stronger, particularly as Indonesia began to ratify its international commitments through COP (Conference of the Parties) agreements. Initially, the Ministry of Public Works did not formally recognize the council, so early collaboration started with the Ministry of Environment, which was responsible for carbon emission calculations.

  Today, the situation has evolved significantly. The speaker highlighted that three ministries now formally collaborate to strengthen the implementation of green building principles in Indonesia: Ministry of Environment, Ministry of Energy and Mineral Resources, and Ministry of Public Works and Housing. These ministries have signed an agreement to integrate green building concepts, including carbon calculation and reduction frameworks into economy development policies.

  The speaker concluded that this multi-stakeholder cooperation is crucial to moving from voluntary initiatives toward mandatory standards for sustainable and green construction materials in Indonesia.

- A participant referred to the speaker's earlier point that developing green infrastructure requires the use of sustainable materials. He noted that, in practice, this means contractors must reduce cement usage and increase the use of wood-based materials. The participant then asked for the speaker's perspective on this, expressing concern that such a shift could potentially trigger illegal logging or reduce natural forest resources.

The speaker acknowledged that this is a very common and valid concern. He clarified that the term “timber materials” in the context of sustainable construction does not necessarily refer to wood from virgin or rainforest sources, but rather from industrial wood or managed plantations.

To illustrate, he mentioned examples from projects in Lombok, where one of the green construction criteria is the use of fast-growing wood species, such as bamboo, which remains a “prima donna” material in sustainable design. However, he noted that bamboo use must be accompanied by careful attention to processing technologies, particularly the resins and adhesives used in engineered wood like CLT (Cross-Laminated Timber) to ensure that the end products remain truly environmentally friendly.

The speaker emphasized the principle of replenishment, explaining that for every tree used, two to five new trees should be planted. This ensures that the resource remains renewable and sustainable over time. He also cited examples from remote areas in Kalimantan, where local communities rely on wood for their daily needs, building small bridges, boardwalks, and houses. Such practices are sustainable when done within the community’s ecological capacity, but what must be avoided is overexploitation.

In Lombok, for instance, the team utilized coconut wood, which is locally abundant and often treated as waste when trees fall naturally. This approach turns waste into a valuable material without harming ecosystems. The speaker concluded that sustainable material use must always balance environmental preservation with local availability, ensuring that green building practices do not come at the cost of forest degradation or biodiversity loss.