D5.6 – Transfer and applicability of BIO4EEB outcomes in the Colombian and Latin American Construction Market

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Executive Summary

This report evaluates the transferability and applicability of BIO4EEB bio-based construction solutions in Colombia and Latin America. It identifies Colombia as the ideal launch market due to its advanced regulatory framework, leadership in green certifications, and institutional readiness.

The study confirms that BIO4EEB outcomes align with regional climate goals, offer significant environmental and social benefits, and support SDGs. With the right policy adjustments, local supply chains, and strategic partnerships, these innovations can drive sustainable transformation in the construction sector across the region.

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Abbreviations and Acronyms

Abbreviation	Description
ABNT	Associação Brasileira de Normas Técnicas
BIO4EEB	Bio Isolation materials For Enhancing the Energy performance of Buildings
BIM	Building Information Modeling
BID	Banco Interamericano de Desarrollo
BREEAM	Building Research Establishment Environmental Assessment Method
CAF	Banco de Desarrollo de América Latina y el Caribe
Camacol	Cámara Colombiana de la Construcción
Camacol Santander	Cámara Regional de la Construcción de Santander
CBIC	Câmara Brasileira da Industria da Construção
CEPAL	Comisión Económica para América Latina y el Caribe
DANE	Departamento Administrativo Nacional de Estadística
ECLAC	Economic Commission for Latin America and the Caribbean
EDGE	Excellent Design for Greater Efficiencies
FAO	Food and Agriculture Organization
ICONTEC	Instituto Colombiano de Normas Técnicas y Certificación
IDB	Inter-American Development Bank
IFC	International Finance Corporation
INN	Instituto Nacional de Normalización
LCA	Lifecycle Assessment
LEED	Leadership in Energy and Environmental Design
UNEP	United Nations Environment Programme
UPME	Unidad de Planeación Minero-Energética
R&D	Research and development
SDG	Sustainable Development Goals
SINAICA	Sistema Nacional de Información de la Calidad del Aire
TRL	Technology Readiness Level

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1 Introduction

1.1 Objective of the Assessment

The current activity is focused on the Study on the transfer and applicability of the developed biomaterials in the Colombian and Latin American Construction Markets.

The use of biomaterials is still at its infancy in the Colombian and Latin American construction markets. With the participation of the Colombian Chamber of Construction (CAMACOL), BIO4EEB will perform a set of activities with the objective of promoting the use of more sustainable materials and circularity principles within the Latin American construction sector. This specific task will perform a detailed market evaluation of the applicability of BIO4EEB materials in the markets covered by CAMACOL as well as potential alternatives to the bio bases used in the project that are more highly prevalent in these geographic regions. When performing this task, it will be important to assess the building typologies for which such approaches are most pertinent at this stage in the market cycle as well as the type of stakeholder most likely to implement such innovative materials and practices. As a result of this market analysis, awareness campaigns and seminars will be organized with the most relevant stakeholders and market players, introducing new best practices and triggering a move towards sustainable construction methods.

The main activity will consist as follows:

- Acknowledge transfer from the European BIO4EEB project to identify similar bio-based materials in Colombia and to explore the possibility of generating products from the region.
- Identification of marketing strategies and assessment of the possibility to expand BIO4EEB products to Latin America, thorough relationship with international allies of CAMACOL.
- Dissemination and communication activities carrying out awareness-raising sessions for using environmentally friendly materials in construction projects with companies, public entities and universities.
- To become a link between government, academia and private companies to achieve higher impact results. In addition, CAMACOL will involve allied international entities to reach more points of interest.

1.2 Scope and Relevance to BIO4EEB

The BIO4EEB project is dedicated to the development of innovative bio-based products aimed at enhancing building efficiency. By integrating sustainable materials, the project seeks to reduce thermal losses, ensuring optimal insulation while maintaining thermal comfort inside buildings. These advancements contribute to a more sustainable and energy-efficient construction sector.

European countries have made significant progress in the development of high-performance materials that not only enhance building energy efficiency but also reduce carbon emissions during the production phase. These innovations align with global sustainability goals, supporting the transition towards a greener and more environmentally responsible construction industry.

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This activity holds great relevance for the BIO4EEB project, especially when considering the Colombian and Latin American construction markets. Currently, there is limited development in both bio-based materials and energy-efficient building solutions in these regions. This gap presents a unique opportunity for market expansion, encouraging the adoption of sustainable and innovative materials that can transform the way buildings are constructed.

By exploring new activities and potential market applications, BIO4EEB can drive a paradigm shift in the construction sector across Latin America. The introduction of bio-based insulation materials will not only enhance energy efficiency but also promote environmental awareness among key industry stakeholders. Ultimately, this initiative has the potential to modernize construction practices, reduce the sector's carbon footprint, and contribute to the creation of sustainable and resilient urban environments.

1.3 Methodology

The study is conducted using a comprehensive and multidisciplinary approach that combines market research, stakeholder interviews, policy reviews, and comparative case studies. By integrating these different methodologies, the assessment ensures a holistic understanding of the potential adoption of BIO4EEB solutions in the Colombian and Latin American construction markets.

The market research component focuses on identifying current trends, demands, and challenges in the construction industry, particularly in relation to bio-based materials and energy-efficient solutions. This includes an in-depth analysis of existing products, pricing structures, supply chains, and the level of industry readiness for sustainable alternatives.

Stakeholder interviews play a crucial role in capturing first-hand insights from key actors, including construction companies, developers, policymakers, regulatory bodies, researchers, and material suppliers. These discussions provide valuable perspectives on the feasibility of adopting BIO4EEB technologies, potential barriers to market entry, and the incentives required to accelerate industry acceptance.

Additionally, a policy review is conducted to evaluate the regulatory framework, building codes, and sustainability standards that influence the use of bio-based insulation materials. Understanding the legislative landscape helps in identifying opportunities for policy alignment, gaps in existing regulations, and potential advocacy strategies to promote wider adoption.

Furthermore, the study incorporates comparative case studies to examine successful implementations of bio-based construction solutions in other regions, particularly in Europe where such technologies have already gained traction. These case studies provide critical lessons and best practices, enabling a more informed approach when proposing strategies for their adaptation to Latin American markets.

The study employs a combination of quantitative and qualitative analysis to provide a data-driven yet contextually rich evaluation of BIO4EEB solutions. Quantitative methods include market size

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estimations, cost-benefit analyses, and energy performance projections, while qualitative approaches focus on narratives from industry experts, behavioral insights, and socio-economic considerations. By synthesizing these findings, the study aims to deliver actionable recommendations that facilitate the successful transfer and applicability of BIO4EEB technologies in the region.

In summary, the study is based on a combination of market research, stakeholder interviews, policy reviews, and comparative case studies. It includes quantitative and qualitative analysis to determine the applicability of BIO4EEB solutions.

2 Overview of BIO4EEB Outcomes Focused on LA

2.1 Key Deliverables for Taks 5.6

BIO4EEB focuses on developing and implementing bio-based insulation materials to enhance energy efficiency in buildings. Key outcomes include:

- Strategies for market penetration and policy alignment.
- List of stakeholders involved, and individuals contacted within the framework of the project implementation.
- Selection, after a brief analysis, of the 3 main markets in Latin American countries for the dissemination of bio-based products in this sector.
- State of the art and regulatory framework for the exploitation of bio-based materials in the prioritized countries.
- Interviews and analysis of responses from key stakeholders.

2.2 Benefits for the Construction Sector

As the construction industry shifts towards more sustainable and energy-efficient solutions, the use of bio-based materials has emerged as a key strategy to reduce environmental impact while maintaining high-performance building standards. The BIO4EEB project integrates advanced technological innovations with sustainability principles, ensuring that its materials not only enhance energy performance but also support eco-friendly construction practices. This chapter explores the technological and environmental advantages of BIO4EEB solutions, focusing on the use of renewable resources, green certifications, and lifecycle assessments to guarantee long-term sustainability.

2.2.1 *Use of Renewable Resources, Bio-Based Materials, and Circular Economy Principles*

BIO4EEB emphasizes the use of renewable and bio-based materials to replace conventional, high-emission construction products. These materials, derived from natural sources such as plant fibers, agricultural residues, and biopolymers, offer a low-carbon alternative to traditional

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insulation materials. Their biodegradability, renewability, and recyclability make them a crucial component of a circular economy, which promotes resource efficiency, waste reduction, and material reuse. By integrating bio-based materials into insulation solutions, BIO4EEB supports a sustainable supply chain that minimizes dependence on fossil fuels while maintaining high thermal and acoustic performance in buildings.

2.2.2 *Compliance with Green Building Standards and Certifications*

For bio-based construction materials to gain widespread adoption, they must comply with international green building standards and certifications. Certifications such as:

- **LEED** (Leadership in Energy and Environmental Design)
- **BREEAM** (Building Research Establishment Environmental Assessment Method)
- **EDGE** (Excellence in Design for Greater Efficiencies)

These standards establish benchmarks for sustainability, energy efficiency, and low-carbon construction. Ensuring that BIO4EEB materials meet these certifications enhances market credibility, regulatory approval, and investor confidence, facilitating their integration into large-scale construction projects.

2.2.3 *Lifecycle Assessment of Materials to Ensure Long-Term Sustainability*

A Lifecycle Assessment (LCA) is conducted to evaluate the environmental footprint of bio-based insulation materials throughout their entire lifecycle—from raw material extraction to disposal. The assessment examines:

- Energy consumption and emissions during production.
- Durability and thermal efficiency in building applications.
- End-of-life recyclability and biodegradability.

By applying LCA methodologies, BIO4EEB ensures that its materials are not only eco-friendly but also economically viable for long-term implementation in the construction industry.

By integrating bio-based materials, technological advancements, and circular economy principles, BIO4EEB aims to transform the construction industry. Its solutions provide a high-performance, low-carbon alternative to traditional building materials, aligning with global sustainability goals while enhancing energy efficiency in buildings. This approach not only reduces the environmental footprint but also encourages the widespread adoption of bio-based innovations in the Latin American and global construction markets.

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2.3 Technological and Sustainable Aspects Focused on LA

2.3.1 *Innovation in Material Composition and Sourcing*

- Development of bio-based insulation materials using renewable, locally adaptable resources.
- Identification of alternative regional bio sources (e.g., agricultural residues, natural fibers) suitable for material adaptation in Latin America.
- Compatibility with existing production technologies, allowing smoother technology transfer and local manufacturing.
- Application of low-energy, low-emission production processes aligned with circular economy goals.

2.3.2 *Integration with Existing Building Systems*

- Technical adaptability of BIO4EEB materials to typical Latin American building typologies, especially in tropical and urban environments.
- Compatibility with conventional construction methods and infrastructure, minimizing the learning curve and retrofitting barriers.
- Performance optimization for thermal comfort and humidity control, crucial for buildings in varied climates across Latin America.

2.3.3 *Lifecycle Performance and Durability*

- Emphasis on long-term performance, including moisture resistance, biodegradability, and structural stability.
- Use of Lifecycle Assessment (LCA) tools to measure environmental impacts from production to end-of-life.
- Identification of maintenance and degradation patterns to inform user and installer training.

2.3.4 *Digital Tools and Data for Market Alignment*

- Use of Building Information Modeling (BIM) or similar tools to simulate integration and performance within local projects.
- Collection of data from interviews and stakeholder engagement to inform future product development and local customization.
- Evaluation of energy efficiency data, aligned with national energy codes and sustainability goals.

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2.3.5 *Compliance with Standards and Certification Pathways*

- Mapping the technological specifications of BIO4EEB outcomes to Latin American green building certifications (e.g., CASA Colombia, EDGE, LEED regional adaptations).
- Identifying gaps and suggesting adjustments to meet local construction regulations.
- Supporting efforts to harmonize European and Latin American standards through policy alignment strategies.

2.3.6 *Scalability and Industrial Feasibility*

- Assessment of production scalability using local facilities or partner networks.
- Analysis of supply chain logistics and technology readiness levels (TRLs) in selected markets.
- Exploration of technology licensing, co-development, or franchising models with local companies for deployment.

3 Market Analysis

The analysis of the construction market is a critical step to assess the feasibility of transferring and adopting BIO4EEB bio-based solutions in Latin America. This chapter is structured to first provide a detailed examination of the Colombian market before expanding to a regional perspective.

Colombia has been identified as the primary entry point for the implementation of BIO4EEB outcomes due to its advanced regulatory environment, high number of EDGE-certified buildings, and strong institutional support from organizations such as CAMACOL and leading financial institutions. Focusing initially on Colombia allows us to understand the specific policy frameworks, market dynamics, and stakeholder landscape that make it a beachhead for innovation in sustainable construction.

Once the Colombian market is assessed in depth, the analysis expands to cover Latin America as a whole, providing an overview of opportunities and challenges in other high-potential markets such as Mexico, Brazil, Chile, and Peru. This structure reflects a strategic approach, where early adoption in Colombia is seen as a platform for regional scalabilityand knowledge transfer to neighboring countries.

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3.1 Colombian Construction Market Overview

3.1.1 *Regulatory Framework: Sustainable Construction in Colombia – Resolution 0149 of 2020*

Resolution 0149 of 2020, issued by the Ministry of Housing, City, and Territory of Colombia, establishes the guidelines for the Technical Regulation for Sustainable Construction (RTCS) applicable to new buildings. This regulatory framework aims to promote the rational and efficient use of natural resources, particularly water and energy, within the construction sector. The regulation requires that new residential construction projects achieve a minimum saving of 20% in water consumption and 20% in energy consumption compared to conventional buildings. For non-residential buildings (such as offices or commercial spaces), the required savings increase to 30% for both resources. (Ministry of Housing, 2025)

This regulatory framework creates opportunities for the incorporation of innovative materials and energy-efficient technologies, such as the bio-based materials developed in projects like BIO4EEB, since the selection of materials that improve the building envelope performance is key to meeting the established requirements.

3.1.2 *Productivity of the Construction Sector in Colombia*

The construction sector in Colombia faces structural productivity challenges. According to figures from DANE and the Private Competitiveness Council (CPC), the sector has shown positive growth rates, but labor productivity has increased at a much slower pace compared to other economic sectors. (Council, 2023)

Key issues include the extensive use of traditional construction methods, low levels of technology adoption, inefficient on-site processes, and limited workforce training. These limitations impact costs, building quality, and delivery times. (DANE, 2023)

The adoption of new sustainable materials, improved construction practices, and solutions that reduce energy and water consumption — such as those offered by BIO4EEB — represent a significant opportunity to enhance sector productivity and align with international efficiency standards.

3.1.3 *Main Players in the Construction Sector in Colombia*

The construction ecosystem in Colombia consists of major construction companies, industry associations, and sector development promoters. Some of the main players include:

- Government
- Banks
- Constructora Bolívar
- Amarilo
- Prodesa

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- Arquitectura y Concreto
- Colpatria Constructora

These developers lead large-scale residential, commercial, and institutional projects and have shown a growing interest in incorporating sustainable construction practices to improve their competitiveness and access financial and tax incentives.

CAMACOL (Colombian Chamber of Construction) plays a coordinating role, connecting public and private sector actors and promoting compliance with environmental and sustainability standards across construction projects. (Camacol, 2024)

3.1.4 *Tax Benefits from UPME for Sustainable Construction*

The Mining and Energy Planning Unit (UPME) offers tax incentives to construction projects that achieve significant improvements in energy efficiency. Through the Tax Benefits Program for Energy Efficiency, companies can:

- Access income tax deductions ranging from 25% to 50%.
- Accelerate the amortization of investments in green technologies.

To apply, projects must demonstrate energy savings through certified technical audits and obtain validation from UPME. This policy encourages the incorporation of innovative solutions such as bio-based materials, which enhance the energy performance of buildings. (UPME, 2023)

3.1.5 *Banking Benefits for Sustainable Construction*

Colombian banks have developed financial products aimed at promoting sustainable construction by offering specialized credit lines and preferential rates for certified projects:

- **Bancolombia:** "Green line" credits and sustainable mortgages, associated with certifications such as EDGE and LEED. (Bancolombia, 2024)
- **BBVA Colombia:** Financing lines for projects certified in energy efficiency and sustainable construction. (BBVA, 2024)
- **Davivienda:** Financial products for EDGE-certified projects and sustainable residential constructions. (Davivienda, 2024)
- **Banco de Occidente, Banco de Bogotá, Banco Caja Social:** Sustainable housing financing programs offering interest rate benefits.

These banking conditions incentivize developers to invest in efficient materials, such as the BIO4EEB outcomes, which facilitate obtaining green certifications. (FINDETER, 2024)

3.1.6 *The Role of Camacol in Promoting Sustainable Construction in Colombia (EDGE Certification)*

Camacol leads the promotion of sustainable construction in Colombia through training programs, alliances with international organizations, and the adoption of certifications such

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as EDGE (Excellence in Design for Greater Efficiencies). (Camacol, National Sustainable Construction Program (EDGE), 2023)(IFC, 2023)

CAMACOL promotes the adoption of EDGE through:

- Training programs for builders and developers in sustainable construction principles.
- Mass certification programs for social housing and commercial housing projects.
- Coordination with financial institutions to link green financing incentives to certified projects.

Through its affiliate network and innovation programs, Camacol represents a key actor for the introduction and expansion of sustainable materials, such as those developed by BIO4EEB, within the Colombian market. (IFC, EDGE Certification Colombia, 2023)

3.2 Latin American Construction Market Overview

3.2.1 *Latin America Construction Market - General Overview*

The construction sector in Latin America plays a fundamental role in the region's economic development, contributing approximately 6% to the regional GDP according to the Economic Commission for Latin America and the Caribbean (ECLAC). Despite its importance, the sector is highly heterogeneous, with significant differences in growth rates, investment flows, regulatory development, and sustainability initiatives between countries. (ECLAC, 2022)

Driven by rapid urbanization, population growth, and the expansion of the middle class, the region shows consistent demand for housing, infrastructure, and commercial developments. However, it also faces persistent challenges, including low labor productivity, limited technological modernization, and high vulnerability to economic and political volatility. (WGBC, 2023)

3.2.2 *Variability in Regulatory Frameworks*

Latin America exhibits substantial variability in sustainable construction regulations across countries:

- Chile and Colombia have established mandatory energy efficiency standards for new constructions and promote green certifications such as CES and EDGE, respectively.
- Mexico applies national energy efficiency standards (e.g., NOM-020-ENER-2011) and regional environmental regulations, but enforcement can vary.
- Argentina, Peru, and Central American countries have initiated voluntary green building programs but still lack consistent mandatory frameworks.
- Brazil leads the region in terms of certified green buildings (LEED, AQUA-HQE), yet regulatory requirements remain largely decentralized.

This regulatory fragmentation presents both barriers and opportunities for the introduction of bio-based materials: in more mature markets, compliance requirements encourage innovation, while in emerging markets, early entrants can shape industry practices.

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3.2.3 *Trends in Green Building Adoption*

There is a growing momentum towards sustainable construction throughout Latin America, reflected in several key trends:

- **Increasing demand for certified buildings** (LEED, EDGE, WELL, and BREEAM certifications are expanding, particularly in Mexico, Colombia, Brazil, and Chile).
- **Government and private sector initiatives** promoting green infrastructure investments, often tied to access to international financing (e.g., IDB, World Bank).
- **Green financing expansion**: banks and financial institutions are increasingly offering **green loans** and **sustainability-linked credits** to construction projects committed to environmental standards.
- **Greater public awareness** about energy efficiency, climate resilience, and sustainable urban development, particularly in major metropolitan areas (e.g., São Paulo, Bogotá, Santiago, Mexico City).

Although adoption is still nascent compared to North America or Europe, the growth curve is steep, making it a strategic time to introduce innovations like BIO4EEB outcomes. (IDB, 2023)

3.2.4 *Potential Partnerships with Regional Construction Firms*

Establishing strategic partnerships with leading regional construction companies is critical for the successful market penetration of bio-based materials. Some potential allies include:

- **MRV Engenharia** (Brazil) – major player in residential construction and strong promoter of green buildings.
- **Amarilo** (Colombia) – actively pursuing EDGE certifications in housing projects.
- **Desarrolladora Homex** (Mexico) – focuses on affordable housing with growing interest in sustainable practices.
- **Cementos Argos** (Colombia) – promotes sustainable construction solutions at scale.
- **Gerdau** (Brazil) – major supplier involved in sustainable building initiatives.

Collaboration opportunities include:

- Pilot projects demonstrating the performance of bio-based insulation and construction materials.
- Joint ventures for localized production and supply chains.
- Knowledge-sharing alliances to train the workforce and stakeholders on sustainable construction techniques.

Partnering with established firms can accelerate market acceptance, enhance credibility, and facilitate compliance with local regulatory requirements.

3.2.5 *Opportunities for Bio-Based Construction Materials*

The introduction of bio-based construction solutions in Latin America faces significant market opportunities in:

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- Affordable housing projects, where sustainable materials can offer cost-effective thermal efficiency.
- Green-certified commercial buildings, were corporate sustainability goals drive material selection.
- Urban regeneration projects aiming to retrofit inefficient building stocks and improve urban resilience.
- Public housing and infrastructure initiatives, often financed through multilateral climate funds or development banks.

BIO4EEB's outcomes align perfectly with these market needs by offering materials that combine sustainability, energy performance, and economic viability.

3.2.6 *Challenges to Overcome*

Despite the promising landscape, certain challenges remain:

- Higher initial costs of sustainable materials compared to traditional options may deter adoption without incentives.
- Limited awareness among developers, contractors, and end-users about the long-term benefits of green buildings.
- Fragmented supply chains and limited local production capabilities for bio-based materials.
- Regulatory inconsistencies and weak enforcement in some markets.
- Technical skill gaps in sustainable design and construction processes.

To address these barriers, a multi-pronged strategy involving market education, policy advocacy, pilot demonstration projects, and local manufacturing partnerships will be crucial.

3.3 Barriers to the Local Manufacturing of Bio-Based Construction Products

Despite the increasing interest in sustainable construction, several structural barriers could hinder the local production of bio-based construction materials in Latin America. Identifying and addressing these challenges is crucial to ensuring the successful transfer and scaling of BIO4EEB outcomes in the region. The main barriers are:

3.3.1 *Limited Availability and Quality of Raw Materials*

- Although Latin America is rich in natural resources, not all countries have the infrastructure or supply chains needed to harvest, process, and standardize bio-based raw materials (e.g., agricultural residues, plant fibers) at an industrial scale.
- Seasonality and variability in biomass quality can affect production consistency and material performance.

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3.3.2 *Lack of Technological Infrastructure*

- Many local manufacturers lack advanced technologies and equipment necessary for processing bio-based composites or insulating materials to meet international quality standards.
- Research and development (R&D) centers specialized in biomaterials for construction are still scarce in the region, limiting innovation capacity.

3.3.3 *Higher Initial Investment Costs*

- Setting up production facilities for bio-based construction products often requires specialized machinery, training, and quality assurance systems, representing a significant upfront financial burden.
- Without clear government incentives or large-scale demand, the risk perception among potential manufacturers remains high.

3.3.4 *Weak Regulatory and Standardization Frameworks*

- The absence of technical standards, certifications, and performance norms specific to bio-based construction products creates market uncertainty and makes it difficult to validate product quality and safety.
- Regulatory approval processes for new materials can be slow and inconsistent across different countries in the region.

3.3.5 *Cultural and Market Acceptance Challenges*

- The traditional construction sector tends to be conservative, favoring well-known materials like concrete, brick, and steel.
- Lack of awareness among developers, architects, and builders about the technical advantages and sustainability benefits of bio-based products limits their market traction.

3.3.6 *Logistics and Distribution Barriers*

- The fragmented geographic structure of many Latin American countries —with remote rural production zones and urban demand centers— increases logistics complexity and transportation costs for bulky or sensitive bio-based materials.

3.4 Strategic Actions to Overcome Barriers

To address these challenges and enable the local manufacturing of bio-based construction products, it will be essential to:

- Develop public-private partnerships to invest in R&D and pilot production plants.
- Promote financial incentives (e.g., tax breaks, subsidies, grants) for manufacturers adopting sustainable production models.

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- Create and harmonize technical standards for bio-based materials.
- Launch awareness and training campaigns targeting construction professionals.
- Establish localized supply chains that ensure the quality and traceability of bio-sourced raw materials.

By proactively tackling these barriers, the region could accelerate the integration of innovative materials like those from the BIO4EEB project, supporting a greener, more resilient construction sector.

3.5 Tends and Opportunities in Bio-based Solutions

The Latin American construction sector is undergoing a gradual but consistent shift toward sustainability, driven by global climate commitments, urban resilience needs, and changing market preferences. Within this context, bio-based construction solutions are gaining attention as a strategic component of sustainable building practices.

Key trends influencing the adoption of bio-based materials in Latin America include:

3.5.1 *Growth of Green Certifications and Standards*

The adoption of green building certifications such as EDGE, LEED, and BREEAM is expanding rapidly across major urban centers. Certification systems increasingly recognize the environmental benefits of using renewable and low-emission materials, creating a formal incentive to integrate bio-based solutions into building designs (World Green Building Council, 2023).

3.5.2 *Government-Backed Sustainability Policies*

Several Latin American countries have incorporated national policies and programs promoting the use of sustainable construction materials, often tied to incentives like tax reductions, preferential financing, and fast-track permitting (IDB, 2023). Although implementation remains uneven, these policy frameworks create fertile ground for the expansion of bio-based alternatives.

3.5.3 *Urban Resilience and Climate Adaptation Strategies*

With increasing exposure to climate-related risks (floods, heat waves, droughts), cities are promoting resilient urban planning. Bio-based materials, due to their thermal regulation properties and low carbon footprint, align closely with urban climate adaptation goals (UNEP, 2023).

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3.5.4 *Rise of Green Financing Instruments*

Financial institutions are offering green bonds, sustainability-linked loans, and preferential mortgage programs tied to environmental performance. This trend enhances the bankability of projects that incorporate bio-based construction solutions (IFC, 2023).

3.5.5 *Growing Consumer Awareness and Demand*

Public perception is shifting toward healthier, environmentally friendly homes and workplaces. Bio-based materials are increasingly associated with better indoor air quality, natural aesthetics, and reduced environmental impact, making them attractive to an emerging eco-conscious middle class (World Bank, 2023).

3.6 Opportunities for Bio-Based Solutions in Latin America

Given the evolving trends, several concrete opportunities for bio-based construction materials are emerging across the Latin American market:

3.6.1 *Affordable and Social Housing Programs*

Governments and private developers are investing heavily in social housing initiatives. Integrating bio-based solutions into these programs can offer cost-competitive, thermally efficient, and sustainable alternatives, especially in tropical and subtropical climates.

3.6.2 *Urban Renewal and Retrofitting Projects*

The need to upgrade existing building stocks, particularly in large cities, presents a strong opportunity for bio-based insulation products and energy-efficient retrofitting solutions (ECLAC, 2022).

3.6.3 *Expansion of Sustainable Commercial Buildings*

Commercial real estate developers seeking green certifications increasingly demand innovative materials to meet strict energy efficiency and sustainability criteria. Bio-based composites and insulation products can support certification efforts and improve building performance.

3.6.4 *Regional Integration of Supply Chains*

There is growing potential to develop regional supply chains for bio-based raw materials (e.g., bamboo, coconut fibers, hemp, agave) across countries like Colombia, Brazil, Ecuador, and Peru, boosting local economies and reducing dependence on imported construction inputs (FAO, 2022).

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3.6.5 *Strategic Alliances and Pilot Projects*

Collaborations with leading developers, municipal governments, and financial institutions can facilitate pilot projects that demonstrate the technical and economic viability of bio-based construction solutions, accelerating market adoption.

4 Transferability of BIO4EEB Outcomes

The transition toward sustainable construction practices has gained traction globally; however, significant differences persist between the European and Latin American construction markets, particularly regarding the implementation and adoption of bio-based materials.

In Europe, the construction sector has been increasingly influenced by stringent environmental regulations, strong governmental incentives, and widespread certification systems such as BREEAM and LEED. Moreover, the European Union has developed coordinated policies and funding schemes that promote circular economy models and support innovation in green construction.

Conversely, in Latin America, the implementation of sustainable practices is still incipient. Although several countries have developed regulations for energy efficiency and green building (e.g., EDGE certification), these standards are not yet uniformly enforced. The use of bio-based materials remains limited, mainly due to the lack of regulatory clarity, market incentives, and technological infrastructure. Furthermore, public awareness and demand for sustainable materials are still emerging, with cost often being a primary decision driver in construction projects.

Despite these gaps, there is growing interest in replicating successful European initiatives like BIO4EEB in Latin American contexts, particularly when supported by tailored strategies that consider local dynamics and constraints.

4.1 Feasibility of Adoption

The feasibility of adopting BIO4EEB solutions in Latin America depends on several key factors:

- **Climate compatibility:** Many Latin American countries possess climatic conditions suitable for leveraging bio-based materials, particularly for passive cooling and thermal performance enhancements.

- **Availability of natural resources:** The region is rich in biodiversity and biomass, presenting opportunities to develop region-specific bio-based materials such as bamboo, hemp, sugarcane bagasse, or coffee waste.

- **Institutional support:** Initiatives led by actors such as CAMACOL in Colombia and public-private alliances in Chile, Brazil, and Mexico, show that there is momentum for integrating

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sustainability in the sector. **(Camacol, Programa nacional de construcción sostenible , 2023)**

- **Market niches:** Social housing, green tourism, and public infrastructure projects provide entry points for bio-based innovations.

Nevertheless, technological transfer must be accompanied by localized R&D and capacity building, since materials developed in European climates and regulatory systems may require adaptation to local needs and building typologies.

4.2 Potential Barriers and Challenges

Despite its potential, the introduction of bio-based construction materials in Latin America faces several structural, regulatory, and socio-economic barriers: (Diaz R., 2022)

- **Regulatory restrictions:** In some countries, there are legal limitations on the extraction or collection of biological raw materials. For instance, environmental regulations may prohibit the commercial harvesting of algae or other plant-based biomass from protected ecosystems, hindering the scalability of certain bio-based products. **(**Sostenible, 2021)

- **Lack of standards and testing protocols:** Most countries in the region do not have technical standards to certify the performance, durability, or safety of bio-based materials, which delays approval and market entry.

- **High initial costs**: Despite long-term savings, bio-based materials often involve higher upfront investments due to limited local supply chains, low economies of scale, and import costs for equipment or raw components.

- **Resistance to change:** Builders and developers often stick to conventional materials due to familiarity and perceived reliability, especially in regions where knowledge about bio-based alternatives is limited.

- **Infrastructural limitations:** Local manufacturing capacity for bio-based components is limited in many countries, which affects cost-efficiency and scalability.

4.3 Strategies for Implementation

To address these challenges and promote the successful implementation of BIO4EEB outcomes in Latin America, the following strategies are proposed: (bank, 2023)

- **Localization of bio-based material sourcing:** Promote the development of supply chains that use regionally abundant and legally available biomaterials (e.g., bamboo, coffee husks, coconut fibers) instead of relying on inputs like algae or European biomass varieties.

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- **Engagement with regulators and environmental agencies:** Encourage dialogue to adapt or clarify regulations related to the sustainable collection of biological materials, while ensuring biodiversity protection.

- **Pilot projects and demonstrators:** Implement demonstration buildings to showcase the technical and financial viability of bio-based materials, especially in public housing or educational facilities.

- **Capacity building and training programs:** Develop educational campaigns for architects, engineers, and builders to increase familiarity and trust in bio-based construction solutions.

- **Financial and policy incentives:** Collaborate with banks, municipalities, and government agencies to create fiscal benefits, green credit lines, or subsidies for sustainable construction.

- **Partnerships with local firms:** Identify construction companies and material producers willing to co-develop and scale up bio-based innovations tailored to Latin American markets.

- **Knowledge exchange:** Strengthen South–North and South–South cooperation by facilitating the transfer of technical know-how from European partners to Latin American stakeholders, aligned with the BIO4EEB mission.

5 Applicability in the Construction Sector

The successful integration of BIO4EEB outcomes in Latin American construction markets depends not only on technological feasibility but also on their practical applicability in real-world projects. This chapter explores how bio-based materials and energy-efficient solutions can be effectively incorporated into the sector by identifying relevant use cases, evaluating regulatory alignment, and engaging key stakeholders throughout the value chain. Given the heterogeneity of Latin American construction practices, tailored strategies that recognize local standards, cultural considerations, and economic dynamics are essential to ensure applicability and scalability. (Camacol, camacol.co, 2023)

5.1 Use Cases and Pilot Projects

To validate and showcase the potential of bio-based construction solutions, use cases and pilot projects play a pivotal role. These projects serve as living laboratories where technical feasibility, cost-efficiency, user satisfaction, and environmental performance can be assessed under real conditions. (America, s.f.)

In Latin America, several promising areas have emerged for pilot implementation. Social housing developments—often publicly funded and aligned with sustainability agendas—represent a

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strategic entry point. For example, Colombia's *Mi Casa Ya* and Brazil's *Casa Verde e Amarela* could serve as platforms for integrating materials developed under BIO4EEB, especially if aligned with EDGE or LEED certification frameworks. (Bank, 2023)

Another opportunity lies in public infrastructure projects such as schools, health centers, or municipal buildings where governments can lead by example and stimulate green public procurement. In Chile and Mexico, university campuses and innovation hubs have also shown interest in piloting green construction solutions, offering visibility and technical credibility.

Demonstration buildings, ideally co-financed by public institutions and development banks (e.g., CAF or BID), are critical to overcoming skepticism and enabling data-driven advocacy for bio-based innovations. (CAF, 2022)

5.2 Alignment with Local Standards and Regulations

For any construction innovation to be widely adopted, it must comply with national and local construction codes, safety standards, and environmental regulations. In Latin America, these frameworks vary significantly across countries and even within regions, posing both a challenge and an opportunity for alignment. (Corporation, 2023)

Countries such as Colombia, Mexico, and Chile have begun integrating sustainability principles into their technical regulations. Colombia's *Resolución 0549 de 2015* and *Resolución 0149 de 2020*, for instance, outline requirements for energy and water savings in new buildings. Brazil has developed *Norma de Desempenho NBR 15575*, which could support the integration of thermal and acoustic properties of bio-based materials.

However, many existing standards do not yet explicitly recognize or evaluate bio-based materials, making it essential to advocate for revisions or pilot-specific permits. Collaboration with national standardization bodies, such as ICONTEC (Colombia), ABNT (Brazil), and INN (Chile), is key to including new materials in official codes.

Aligning BIO4EEB outcomes with these frameworks will also require documented performance data, lifecycle assessments, and compliance with fire safety, durability, and toxicity regulations.

5.3 Stakeholder Engagement

The widespread adoption of bio-based construction materials depends heavily on the involvement and coordination of multiple stakeholders across the construction ecosystem. These include architects, engineers, developers, construction companies, material suppliers, regulators, financial institutions, and end users.

Stakeholder engagement strategies must focus on building trust, increasing technical awareness, and demonstrating the added value of BIO4EEB solutions. Professional associations such as CAMACOL (Colombia), SINAICA (Mexico), and CBIC (Brazil) serve as essential platforms for knowledge dissemination and training.

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Engagement should also include early dialogue with government agencies to secure public support and co-create policies that facilitate innovation. Financial actors, including green investment funds and commercial banks—can play a catalytic role by incorporating bio-based materials into their eligibility criteria for sustainable finance.

Finally, engaging local communities in the design and use of these solutions ensures cultural appropriateness, enhances adoption, and aligns with social sustainability goals.

5.4 Assessment of Building Typologies for BIO4EEB Materials in Colombia and Latin America

The evaluation of building typologies is a crucial step in identifying where the promotion of sustainable bio-based materials and circularity principles can have the most significant impact. In Colombia and Latin America, the diversity of climates, market maturity, and social needs shapes the potential applicability of BIO4EEB outcomes such as bio-PUR foams, rice husk composites, Posidonia-based insulation, PEC, and PLA panels.

One of the most relevant typologies is social housing (Vivienda de Interés Social – VIS), which represents more than 60% of new residential units constructed annually in Colombia (Camacol, 2023). Social housing presents an opportunity to integrate locally available agro-waste residues such as rice husks, sugarcane bagasse, and coffee husks into insulation boards and composites. These materials can reduce energy consumption and improve thermal comfort, thereby lowering utility costs for low-income households. Moreover, because many VIS projects are aligned with EDGE certification schemes, bio-based products can be directly connected to green finance instruments that are increasingly demanded by developers and banks (IFC, 2023).

Educational facilities, such as schools and universities, also represent a strategic entry point. Colombia's Plan Nacional de Infraestructura Educativa foresees substantial investments in new and renovated schools, which require both acoustic and thermal comfort. Bio-PUR foams and rice husk-based panels are particularly suited for this context, while their use in educational infrastructure could also serve as highly visible demonstration projects that raise awareness of sustainable construction practices among students, teachers, and communities (Camacol, 2023).

A third key typology is public health infrastructure, including hospitals and clinics, which is expanding under Colombia's Plan Nacional de Desarrollo 2022–2026. These buildings have strict requirements for insulation, hygiene, and acoustic performance. While bio-based solutions such as bio-PUR and PLA composites can deliver strong environmental benefits, their adoption will require rigorous certification processes through Colombian technical standards (ICONTEC) to meet health-sector regulations. This underscores the importance of coupling technological innovation with regulatory adaptation (Minvivienda, 2020).

Commercial and office buildings also represent an important market segment. In urban centers like Bogotá, Medellín, and Cali, large developers are actively seeking LEED and EDGE

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certifications to improve competitiveness and attract investment. In these projects, bio-based insulation materials and PLA-based wall partitions can reduce cooling loads and support sustainability goals, while also offering developers a reputational advantage (IFC, 2023). Similarly, the hospitality and tourism sector, particularly in coastal areas such as Cartagena and San Andrés, is experiencing growing demand for eco-certified hotels and lodges. Here, the integration of bio-based materials such as bamboo composites, bagasse panels, and Posidonia insulation can align construction practices with the region's positioning as a sustainable tourism destination (CAF, 2022).

Finally, industrial warehouses and logistics centers are an emerging but promising typology. Driven by the rapid growth of e-commerce in Latin America, these large-scale facilities are increasingly focused on energy efficiency. Bio-PUR insulation and rice husk-based roof and wall panels can significantly reduce energy consumption for cooling in hot and humid climates, while also valorizing agricultural residues in circular economy models (World Bank, 2023).

In summary, the typologies with the highest short-term applicability are social housing, schools, and public infrastructure, due to their scale, social impact, and alignment with public policy. Commercial and hospitality projects represent medium-term opportunities, primarily driven by market visibility and green certifications, while warehouses and logistics facilities are emerging areas that can become significant drivers of bio-based material adoption in the near future.

6 Business Models and Marketing Strategies

As the adoption of sustainable construction solutions continues to grow in Latin America, establishing viable business models and effective marketing strategies becomes essential for ensuring the successful transfer and scaling of BIO4EEB outcomes in the region. This chapter explores market segmentation, identifies the ideal "beachhead market" for entry, and presents actionable models and promotional tactics, drawing on global experiences and lessons learned from similar initiatives.

6.1 Market Segmentation

To prioritize target countries for the deployment of bio-based construction materials, a segmentation was conducted based on three criteria:

- **Market size** (total construction investment, urban growth)
- **Regulatory maturity** (existence and enforcement of green building standards)
- **Progress in sustainable construction** (number of certified projects, public/private initiatives)

The following image shows those countries that resulted the most attractive in order to the previous criterions: Mexico, Colombia, Brazil, Perú, Chile and Argentina

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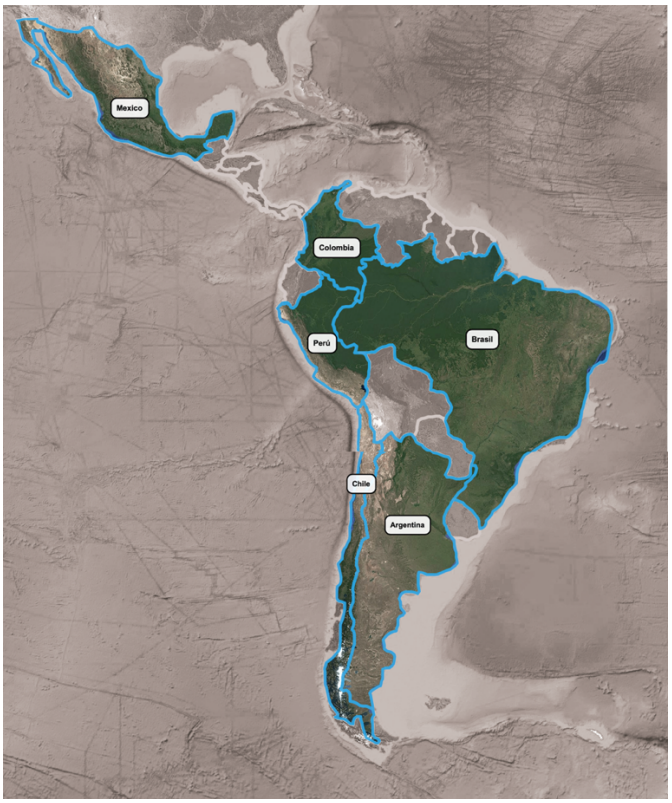

Figure 1: *Most attractive countries in Latinamerica*

Hereby, the table categorizes each criterion in order to choose one of the prioritized countries:

Country	Market Size	Regulatory Maturity	Progress in Green Building	Comments
Brazil	Very High	Medium	High (LEED, AQUA-HQE widespread)	Large market, fragmented regulation
Mexico	High	Medium-High	High (LEED, NOM standards, local codes)	Strong public-private collaboration
Colombia	Medium-High	High (Resolution 0149)	High (EDGE leader in LATAM)	Strong role of CAMACOL
Chile	Medium	High	Moderate (CES standard)	Politically stable, innovation-friendly
Peru	Medium	Low	Low	Opportunity for early entry
Argentina	Medium	Low	Low	Policy inconsistency, economic volatility

Table 1: *Criterion to prioritized countries*

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Sources: IFC (2023), World Bank (2023), Camacol (2023), Green Building Council Latin America reports (2022–2023)

6.2 Beachhead Market

A **beachhead market** is the ideal starting point for entering a new region—offering a balance between opportunity and feasibility. Based on the segmentation criteria above, **Colombia** stands out as the most suitable beachhead for the implementation of **nature-based and bio-based construction solutions** due to:

- **Regulatory support:** Mandatory sustainable construction regulations (Resolution 0149).
- **Institutional leadership:** CAMACOL actively promotes green materials and certifications.
- **EDGE certification momentum:** Colombia leads in EDGE-certified residential buildings in LATAM.
- **Stakeholder maturity:** Financial institutions (e.g., Bancolombia, Davivienda) already link financing to sustainability criteria.
- **Supply potential:** Agricultural regions offer bio-based input sources (e.g., coffee husks, fique fiber, sugarcane bagasse).

Criterion	Colombia
Regulatory Environment	Strong (Resolutions 0549/2015 and 0149/2020)
Stakeholder Engagement	High – CAMACOL, financial institutions involved
Market Receptivity	High – EDGE certification growth
Supply Chain Potential	Strong – agricultural residues available
Pilot Project Opportunities	Social housing, schools, public buildings

Table 2: *Criterion to Colombia*

As a conclusion, Colombia presents the most favorable combination of regulatory readiness, institutional support, supply availability, and certification momentum for the early adoption of BIO4EEB solutions.

EDGE Certification Data – Top 5 Latin American Markets

Country	Total Certified Floor Area (m²)	Global Rank in EDGE Certifications
Colombia	9,680,000	**#1 in Latin America**
Mexico	5,420,000	#2
Brazil	3,870,000	#3
Peru	2,160,000	#4
Chile	1,530,000	#5

Source: *EDGE Buildings (IFC, 2024) – Public project data dashboard.*

Table 3: *EDGE Ranking Latin America*

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6.3 Proposed Business Models for Adoption

The adoption of BIO4EEB solutions in Latin America requires context-adapted business models that account for market structure, investment capacity, and local partnerships. Recommended models include:

A. License-to-Produce Model
- Local firms obtain licenses to produce or adapt BIO4EEB bio-based materials.
- Reduces shipping costs and enhances local economic participation.
- Suitable for regions with limited R&D but strong manufacturing base.

B. Public-Private Demonstration Alliances
- Projects co-funded by local governments, international donors (e.g., IDB, CAF), and private developers.
- Builds credibility through flagship buildings (e.g., schools, social housing).

C. Integrated Product-Service System (IPSS)
- Companies sell insulation material with installation, maintenance, and certification support.
- Increases value proposition and ensures performance compliance.

D. Franchise or Joint Venture Model
- BIO4EEB partners with regional construction conglomerates or material distributors.
- Ensures market access and reduces entry barriers through local brand recognition.

6.4 Marketing Strategies for Bio-based Construction Solutions

Effective marketing strategies should highlight both **performance and sustainability benefits**, tailored to different stakeholders (developers, policymakers, end-users). Key recommendations include:

- **Targeted Awareness Campaigns:** Showcase environmental and health benefits of bio-based materials (e.g., improved thermal comfort, reduced VOCs, lower carbon footprint).
- **Storytelling and Case-Based Marketing:** Use relatable narratives showing how local communities benefit from nature-based construction.
- **Demonstration Projects and Open House Events:** Allow stakeholders to experience the materials firsthand.
- **Certification-Focused Positioning:** Highlight compatibility with EDGE, LEED, or local standards.
- **Influencer and Trade Association Engagement:** Work with green building councils and sustainability advocates in each country.
- **Visual Identity and Branding:** Ensure that bio-based materials are associated with innovation, comfort, and economic value—not just “ecology”.

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6.5 Case Studies of Similar Success Stories

The success of bio-based construction in other regions offers valuable lessons. Examples include:

The following case studies illustrate successful examples of bio-based construction material adoption in different geographic and economic contexts. They demonstrate how innovative business models, strategic partnerships, and targeted pilot projects can support the deployment and scaling of sustainable building solutions. These cases offer valuable insights for replicating similar approaches in Latin America.

1. **Ecococon (Lithuania)**

This case demonstrates how a nature-based solution using locally available materials—straw and natural fibers—can achieve widespread acceptance across multiple countries. Ecococon's prefabricated wall panels are designed to meet passive house standards, appealing to both eco-conscious consumers and institutional clients. Their licensing and prefabrication model ensures scalability while maintaining quality. (Ecococon, 2023)

Criterion	Relevant Information
Product:	Modular panels made of straw and natural fibers
Business Model:	B2B licensing with prefabrication approach
Impact:	Over 200 certified buildings in 12 countries
Website:	https://ecococon.eu/

Table 4: *Case study Ecococon*

- Modular panels made of straw and natural fibers used in passive houses across Europe.
- Business model based on prefabrication and B2B licensing.
- Result: >200 certified buildings in 12 countries.

2. **BioBIP Portugal**

This case highlights the value of innovative ecosystems in accelerating sustainable material adoption. BioBIP serves as a business and innovation platform that brings together small- and medium-sized enterprises (SMEs), research institutions, and government actors to develop and commercialize cork-based insulation. The project illustrates how collaboration can overcome technical and market barriers.

Criterion	Relevant Information
Focus:	Cork-based insulation materials
Strategy:	Collaboration between SMEs, academia, and certification bodies
Support:	Innovation and startup ecosystem

Table 5: *Case study BioBIP*

- Innovation hub developing cork-based insulation in partnership with SMEs.

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- Strong collaboration with universities and certification agencies.

3. GreenFique (Colombia) – Local Example

As a local example from Latin America, GreenFique shows the potential of adapting traditional agricultural resources—fique fiber—into a high-value construction product. Through partnerships with CAMACOL and regional development agencies, GreenFique has launched pilot projects in eco-tourism and rural housing, serving as a scalable model for community-based sustainable innovation. (Fique, 2023)

Criterion	Relevant Information
Product:	Fique fiber insulation for thermal/acoustic use
Application:	Eco-tourism and rural housing projects
Partnerships:	CAMACOL and regional development agencies
Status:	Local pilot projects underway

Table 6: *Case study GreenFique*

- Startup using fique fiber as an acoustic and thermal insulation material.
- Products used in eco-tourism projects in Santander.
- Partnered with CAMACOL to access pilot projects.

6.6 Annex 4: Proposed Business Model for Colombia

Given Colombia's regulatory readiness and market maturity, the most suitable business model to implement BIO4EEB outcomes is a **Public-Private Demonstration Alliance with a Local License-to-Produce** approach:

- **Public-Private Demonstration Alliance:** To showcase the viability of the materials, early-stage projects should be co-financed with public agencies (e.g., Ministry of Housing, CAMACOL) and international partners (e.g., IFC, IDB). Projects in schools, social housing, and healthcare centers can provide visibility and performance data.
- **License-to-Produce Model:** Granting licenses to local SMEs or manufacturers to produce BIO4EEB materials locally using regionally available biomass (e.g., coffee husks, sugarcane bagasse) ensures cost efficiency and community engagement.

This hybrid model fosters scale, local ownership, and public sector validation.

6.7 Annex 5: Marketing Strategies for the Colombian Market

To maximize impact in Colombia, the following targeted strategies are recommended:

- **Stakeholder Positioning:** Present BIO4EEB as a technical solution aligned with national green building goals (Resolution 0149, EDGE adoption).

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- **Influencer and Technical Advocacy:** Collaborate with thought leaders in construction, architects, and sustainability consultants.
- **Demonstration Building Tours:** Organize site visits to showcase thermal comfort and aesthetic appeal.
- **Certification Campaigns:** Link BIO4EEB materials to faster or cheaper EDGE certification processes. (IFC, EDGE Builginds, s.f.)
- **Government Partnerships:** Work with national and regional governments to include BIO4EEB in public tenders for green infrastructure.
- **Educational Media:** Develop explainer videos and infographics tailored to developers and construction workers.

This data confirms Colombia's regional leadership in sustainable construction and strengthens the case for prioritizing it as the primary implementation site for BIO4EEB outcomes.

7 Environmental and Social Impact

7.1 Contribution to Sustainability Goals

The implementation of BIO4EEB outcomes in Colombia and the broader Latin American context directly supports multiple United Nations Sustainable Development Goals (SDGs): (UNDP, 2022)

- **SDG 7 (Affordable and Clean Energy):** By improving building envelope performance, bio-based insulation materials reduce the need for mechanical cooling and heating, leading to more energy-efficient buildings.
- **SDG 9 (Industry, Innovation and Infrastructure):** The promotion of locally manufactured bio-based materials encourages innovation, supports SMEs, and contributes to the development of sustainable industrial infrastructure.
- **SDG 11 (Sustainable Cities and Communities**): Bio-based construction contributes to climate-resilient urban development, enhancing comfort and energy performance in housing, especially in vulnerable urban zones.
- **SDG 12 (Responsible Consumption and Production):** The use of renewable, biodegradable, or agricultural waste-derived materials supports circular economy principles.
- **SDG 13 (Climate Action):** Reducing the carbon footprint of the construction sector is essential for national climate goals; bio-based products sequester carbon and reduce emissions compared to conventional materials.

In Colombia, where the construction sector is one of the top contributors to greenhouse gas emissions (IDEAM, 2023), the use of BIO4EEB solutions aligns with national sustainability strategies and the Nationally Determined Contributions (NDCs).

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7.2 Environmental Benefits

Implementing bio-based materials at scale would generate substantial environmental benefits across the region:

- **Reduction of CO_2 emissions:** Replacing traditional insulation materials (e.g., polystyrene, mineral wool) with plant-based options can reduce embodied carbon. (Bank, World Bank, 2023)
- **Waste valorization**: Use of agricultural residues such as sugarcane bagasse, coffee husks, or fique fibers supports sustainable waste management.
- **Resource efficiency:** Bio-based materials typically require less energy and water to produce compared to synthetic alternatives.
- **Biodiversity protection**: By sourcing biomass responsibly and locally, pressure on protected ecosystems is reduced, and illegal extraction (e.g., of algae or forest resources) can be avoided.

7.3 Social and Economic Benefits

The adoption of BIO4EEB bio-based construction solutions would also deliver important social and economic impacts:

- **Job creation in rural areas:** Establishing local supply chains for raw material harvesting and processing generates employment in agricultural regions.
- **Capacity building:** The deployment of new technologies requires training and education, improving workforce skills in green construction techniques.
- **Affordability for vulnerable populations:** Bio-based materials can reduce energy bills for low-income families by enhancing thermal comfort and lowering reliance on artificial cooling.
- **Strengthening local economies:** Encouraging local production reduces imports, fosters entrepreneurship, and supports inclusive growth.

In Colombia, these impacts are particularly significant given the government's focus on post-conflict rural development, where bio-based value chains can play a transformational role.

8 Recommendations and Strategies for Regional Adoption

8.1 Priority Actions for Adoption in Colombia

Colombia's advanced regulatory environment, its leadership in certified green buildings, and the proactive role of institutions like CAMACOL position the country as an ideal starting point for implementing BIO4EEB solutions. To consolidate this potential and transition toward widespread adoption of bio-based materials, several strategic actions are recommended. (Camacol, Camacol, 2023)

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One of the most immediate priorities is to adjust existing policies to facilitate market entry. Although Colombia has sustainability-oriented construction regulations—such as Resolution 0149 of 2020—many of them lack specific language that includes or supports bio-based materials. Therefore, it is important to update national technical standards (NTC) to explicitly recognize these materials, introduce tax incentives or fast-track permits for projects that use certified bio-based products, and encourage the integration of such materials into public programs like "Mi Casa Ya." (IFC, EDGE Buildings, s.f.)

Developing local supply chains will also be essential. Colombia possesses rich agricultural zones that produce residues like coffee husks, sugarcane bagasse, and fique fibers—ideal raw materials for construction-grade bio-products. Encouraging local production through rural cooperatives and SMEs not only reduces reliance on imports but strengthens rural economies. Collaborations with certifying entities such as ICONTEC can help ensure the quality and traceability of these materials.

In parallel, partnerships with academic institutions are crucial for scientific validation and long-term sustainability. Establishing joint research programs with universities like Universidad Nacional, Universidad de Los Andes, or Universidad del Valle will contribute to the development and testing of new bio-based materials. These institutions can also serve as training hubs for architects, engineers, and construction professionals, promoting bio-based construction methods through curriculum inclusion and hands-on experimentation.

8.2 Regional Adaptation Strategies for Latin America

Latin America is characterized by wide-ranging climatic, social, and economic conditions. For the adoption of BIO4EEB technologies to be successful across the region, strategic adjustments are needed to fit each national and regional context.

A core recommendation is the customization of materials and technologies according to local climate conditions and building typologies. (Minvivienda, s.f.) For example, in tropical or humid regions such as Colombia's Caribbean coast or parts of the Amazon basin, materials should be optimized for moisture resistance. Meanwhile, in arid or temperate zones like the Mexican plateau or Andean highlands, insulation properties must be tested and validated for thermal performance.

It is also important to prioritize high-potential markets where regulatory maturity and market readiness align. Countries such as Mexico, Brazil, and Chile stand out:

- Mexico combines high EDGE adoption with strong institutional and financial support for sustainable construction.
- Brazil has the largest manufacturing base and public investment capacity in the region, which can scale production quickly.
- Chile is politically stable and known for early regulatory adoption and innovation in green urban development.

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To scale these solutions, establishing regional innovation hubs can localize production and facilitate cross-border knowledge sharing. Supporting this with mutual recognition of certification standards and South–South cooperation frameworks—replicating Colombia's pilot experiences in neighboring countries—will create the foundation for long-term impact.

8.3 Suggested Partnerships and Collaborations

Collaborative action is the key to unlocking the potential of bio-based construction in the region. Multi-sectoral partnerships will allow the solutions developed by BIO4EEB to be tested, validated, and adopted at scale.

Engagement with national and regional construction industry associations should be a first step. Institutions like CAMACOL in Colombia, CBIC in Brazil, and the Chilean Chamber of Construction (CChC) have strong policy influence and networks that can drive awareness and policy reform. These entities can also facilitate sector-wide dialogues to identify common barriers and promote inclusive innovation.

At the project level, early pilot partnerships with major developers such as Marval, Amarilo, Constructora Bolívar, or Prodesa will be vital. Demonstration projects in schools, social housing, or public buildings can visibly showcase the thermal, acoustic, and environmental benefits of bio-based materials. The results from these pilots—both technical and economic—should be well-documented to build evidence and trust.

Financing remains a critical enabler. Funding mechanisms may include:

- Innovation grants from international organizations such as IFC, IDB Lab, or UN Habitat; (UN-Habitat, 2023)
- Blended financing schemes that combine public subsidies with private investment; (Bank, World Bank, 2023)
- Partnerships with green finance institutions like Bancolombia or Davivienda that already offer sustainability-linked credit lines.

When these partnerships are well-coordinated and strategically executed, they can transform not only construction practices but also the economic and social fabric of the regions involved.

9 BIO4EEB Materials: On-the-Ground Applicability

9.1 Bio-PUR (bio-based polyurethane foams and systems)

Where it fits: thermal/acoustic insulation, sealants, adhesives. Open-cell foams suit warm-humid and temperate Andean climates; closed-cell foams are suitable for vapor control in Bogotá or coastal areas.

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Why it's viable: Bio-polyols from vegetable oils are already proven for low-density insulation foams; recent work shows ultralight, open-cell bio-PUR with competitive thermal conductivities (Liu et al., 2024).

Certification angle: Bio-polyols partially displace fossil content, contributing to EDGE credits for embodied energy reductions (IFC, 2023a). Colombia's high uptake of EDGE certifications strengthens the business case (IFC, 2023b).

Supply & scaling: Polyols can be sourced from soy or castor oils in Latin America; foaming applications can use existing local contractors.

Watch-outs: Applicators must control moisture and VOCs.

Closest local substitutes:

- **Sugarcane bagasse-based panels,** proven in Brazilian and Colombian studies (Rodríguez et al., 2016; Pereira et al., 2024).
- **Fique-fiber composites** as reinforcements and insulation mats (Mejía-Arcila et al., 2022; Figueroa et al., 2019).

9.2 Posidonia (seagrass) fibres/mats

Where it fits (in Europe): used as insulation (e.g., NeptuTherm®) (Bundespreis Ecodesign, 2022).
Colombia/LatAm reality: *Low direct transferability.* Posidonia is Mediterranean and often ecologically protected.

Best regional substitutes:

- **Rice husks and straw fibres** for insulation/acoustic boards (López-González et al., 2023).
- **Coconut coir and sugarcane bagasse residues** for panels (Pereira et al., 2024).
- **Fique fibres** for insulation mats in Colombia (Mejía-Arcila et al., 2022).

9.3 Rice fibres (husk/straw)

Where it fits: Insulation boards and lightweight panels. Strong potential in rice-growing regions of Colombia.
Evidence base: Blends of rice husks and cellulose achieve viable conductivity and durability (López-González et al., 2023).
Certification angle: Helps meet EDGE "Materials" requirements (IFC, 2023a).

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9.4 PEC (poly(ethylene carbonate))

What it is: CO_2-based biodegradable polymer with potential binder applications.
Reality check: Limited outdoor durability and building standards (Liu et al., 2023).
Practical path: Pilot PEC as a **binder** in bagasse or rice husk panels, benchmarked against urea-formaldehyde resins.
Local substitutes: Starch, lignin, and tannin binders, which are already researched in Latin America (Pereira et al., 2024).

9.5 PLA (polylactic acid) foams & composites

Where it fits: foamed insulation panels, 3D-printed claddings, acoustic boards.
Why it's promising: Feedstock (sugarcane, corn) is abundant in LatAm. Blends with bagasse or rice husks can lower costs.
Caveats: Susceptible to hydrolysis in humid climates (Zhou et al., 2020).
Certification: PLA blends contribute to biobased content credits (IFC, 2023a).

9.6 Fast-Track Local Alternatives (LatAm)

- **Sugarcane bagasse panels** (Rodríguez et al., 2016; Pereira et al., 2024).
- **Fique fibres** in composites and insulation (Mejía-Arcila et al., 2022).
- **Guadua bamboo** structural and panel elements, supported by Colombian building codes (Better Bamboo Building, 2022; Morales et al., 2018).
- **Rice husk/straw boards** (López-González et al., 2023).
- **Coffee husk, coconut coir** for acoustic panels (Pereira et al., 2024).

9.7 Regulatory & Certification Fit

- **EDGE certification** requires 20% efficiency thresholds in energy/water/materials; Colombia has the highest number of EDGE-certified buildings in Latin America (IFC, 2023b).
- **Colombian standards (NSR-10, ICONTEC)** provide acceptance routes for bamboo, bagasse, and fique-based boards (Better Bamboo Building, 2022).

10 Conclusions

The transfer and applicability of BIO4EEB outcomes in Colombia and Latin America present significant opportunities for sustainable growth in the construction sector. While challenges exist, strategic engagement, regulatory alignment, and business model innovation can facilitate successful adoption.

The comprehensive analysis developed in Deliverable 5.6, covering eight thematic areas, confirms that the outcomes of the BIO4EEB project are not only technically viable but highly

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strategic for fostering sustainable transformation in the Latin American construction sector, with Colombia as the ideal launching ground. The project outcomes align with national sustainability policies, public housing initiatives, and the goals of climate-resilient urban development.

The technological innovations offer real potential to improve thermal comfort, reduce carbon emissions, and promote responsible use of natural resources. Moreover, they present strong synergies with the green finance ecosystem, EDGE certification incentives, and public-private investment opportunities. The feasibility of adoption is high, and the market shows signs of readiness—especially in Colombia—although addressing regulatory gaps, boosting awareness, and developing local supply chains remain key challenges. (CAF, Building Resilient Citiesthrough innovation and green infrastructure in Latin America, 2022)

In terms of broader impact, the project contributes directly to five Sustainable Development Goals, enables rural job creation through bio-based value chains, and promotes a new generation of low-carbon building practices. With strategic partnerships, a clear implementation roadmap, and targeted investment in capacity building and pilot demonstration, BIO4EEB has the potential to become a catalyst for change in the region.

The findings compiled across the current document demonstrates the considerable potential of bio-based construction materials to accelerate the transition toward sustainable building practices in Colombia and Latin America. The main conclusions are:

- **Market Transferability:** Although differences exist between European and Latin American construction markets, the demand for sustainable, cost-efficient materials is increasing. Colombia presents the most favorable context for early adoption, given its regulatory maturity and leadership in EDGE certifications.
- **Feasibility and Barriers:** Adoption is technically and climatically feasible, especially when paired with adaptations to local conditions. Key barriers include regulatory gaps, cultural resistance to innovation, and restricted access to bio-based inputs due to environmental regulations.
- **Implementation Strategy:** A hybrid business model combining licensing for local production with public-private pilot projects is ideal for Colombia. Regional scaling depends on establishing technology hubs and cross-border cooperation.
- **Marketing and Positioning:** Bio-based solutions must be linked to economic savings, thermal comfort, and contribution to certification schemes. Demonstration buildings and campaigns with industry influencers will support credibility and awareness.
- **Environmental and Social Impact:** These materials significantly reduce carbon emissions, valorize agricultural waste, and generate jobs in rural areas. They align directly with five SDGs, including SDG 7 (Clean Energy), SDG 11 (Sustainable Cities), and SDG 13 (Climate Action).
- **Colombia as the Beachhead Market:** Thanks to its high regulatory alignment, growing network of certified green buildings, and institutional partners like CAMACOL and Bancolombia, Colombia is positioned as the most strategic entry point for BIO4EEB solutions in Latin America.

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- **Regional Strategy:** Mexico, Brazil, and Chile are secondary high-potential markets. Tailored materials and mutual recognition of standards will be key to successful regional transfer.
- **Recommended Actions:** These include updating policies, training stakeholders, fostering academic partnerships, and mobilizing international green financing to support demonstration and early-stage adoption.

These conclusions reinforce the strategic opportunity for BIO4EEB to become a catalyst for innovation and low-carbon transformation in the Latin American construction sector.

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Annexes

Annex 1. Resolution 0149 of 2020 (Colombia)
Foundational document of the regulatory framework for sustainable construction in Colombia.
Suggested content: Excerpt from the regulation indicating the required percentages of water and energy savings, or a summary table of the requirements.

Annex 2. Comparative Table: Regulations in Latin America
Comparison of sustainable standards in countries such as Colombia, Brazil, Mexico, and Chile.
Suggested content: Table including key regulations, year of issuance, regulatory authority, and relevant technical requirements.

Annex 3. Pilot Cases or Public Programs
Detailed information on programs such as Mi Casa Ya (Colombia), Casa Verde e Amarela (Brazil), and their possible links to sustainable projects.
Suggested content: Technical sheets or a summarized description of scope, requirements, and coverage.

Annex 4. Tax and Banking Incentives
Details of incentives offered by UPME and Colombian banks.
Suggested content: Table listing the entity, type of benefit (tax deduction, preferential rates), and access conditions.

Annex 5. EDGE Certification in Latin America
Summary of certified projects or those in the process of certification.
Suggested content: Map or list showing the number of projects per country, type of building, and project stage.

Annex 6. Technical Sheets of BIO4EEB Solutions
Although not shared directly, if product datasheets exist (e.g., insulation, cladding, panels), it is recommended to include them.
Suggested content: Thermal and acoustic properties, carbon footprint, durability, etc.

Annex 7. Regulatory Barriers for Biomass Use (e.g., algae)
Local regulations or restrictions that prohibit or limit the use of certain raw materials.
Suggested content: Legal excerpts or official interpretations.

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