

Roadmap

ReBuilt Thimphu-Paro

Shaping Bhutan's Regenerative Built Environment by Linking Local Material Resources, Enabling Regulatory Frameworks, and Regional Innovation



Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety



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Roadmap Thimphu-Paro

Shaping Bhutan's Regenerative Built Environment by Linking Local Material Resources, Enabling Regulatory Frameworks, and Regional Innovation

as part of:

ReBuilt: Transformation Pathways Towards
a Regenerative Built Environment

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Foreword

by Tashi Penjor

Director of the Department
of Human Settlement
Ministry of Transport and
Infrastructure Bhutan

It is with profound honor that I present this Collaborative Roadmap for the Transition to a Regenerative Built Environment, an effort fundamentally inspired by the Kingdom of Bhutan's core commitment to Gross National Happiness (GNH). This aligns the built environment with our constitutional pledge to remain perpetually carbon-neutral.

The construction sector is globally responsible for a staggering 37% of energy and process-related CO2 emissions, and its heavy reliance on imported, energy-intensive materials challenges our national climate goals. This roadmap is our strategic guide, transforming construction from a carbon liability into a powerful mechanism for environmental and societal regeneration, actively strengthening our communities, culture, and natural capital.

We must balance the pressing demands of housing and infrastructure growth in urban centres with our unwavering commitment to sustainable development. This roadmap provides the tangible, actionable steps required for this crucial balance.

Our strategic focus is on unlocking the potential of abundant domestic, nature-based materials – specifically sustainably managed timber, bamboo, hemp, and earth. By strengthening resilient local value chains, we generate green jobs, reduce foreign exchange outflow, and preserve the traditional knowledge that defines our unique architectural identity.

Success requires robust and sustained collaboration among government leadership, academia, and the private sector. The five central fields of action outlined herein form the comprehensive foundation for a truly carbon-neutral and inclusive future, making this roadmap a tangible, living expression of GNH.

I express my sincere gratitude to all national and international partners whose instrumental support shaped this vision. I strongly encourage all government agencies, the private construction industry, and the academic community to embrace this roadmap and take collective ownership of its results to strengthen national frameworks conducive to a truly regenerative and GNH-focused built environment.



Executive Summary

Bhutan's built environment faces growing pressure from rapid urbanisation, rising material demand, and continued dependence on imported, emission-intensive resources, challenging the country's long-standing environmental commitments. While Bhutan remains one of the few carbon-negative nations, projections indicate that this balance could shift by 2050 if current construction trends persist. The building sector – already among the most resource- and labour-intensive parts of the domestic economy – therefore holds both the responsibility and the opportunity to lead Bhutan's transition towards a regenerative, low-carbon future.

This roadmap outlines a strategic framework for establishing a regenerative construction sector that is carbon-neutral, socially inclusive, economically viable, and culturally grounded. It builds on three years of research and stakeholder engagement under Bauhaus Earth's ReBuilt project, aligning with national development priorities articulated in the 13th Five-Year Plan. The roadmap's vision is clear: to harness Bhutan's natural resources, institutional capacities, and cultural values to shape a built environment that enhances ecological integrity, creates dignified employment, and strengthens community resilience.

Translating Bhutan's long-standing principles of environmental stewardship and Gross National Happiness into actionable pathways for the built environment, the roadmap aligns **five Regional Opportunities** (ROs) as strategic entry points for a transformation towards a regenerative built environment:

1. Leveraging Bhutan's vast natural resources to establish nature-based value chains for the construction sector:

This field of action focuses on building reliable domestic value chains for timber, bamboo, hemp, and earth-based materials. Actions include closing data gaps on biomass availability, improving sustainable forestry management, and upgrading timber processing and distribution systems. Parallel efforts support new agricultural value chains through industrial hemp and bamboo cultivation, while earth construction practices are assessed for modern scalability.

2. Utilising global and regional R&I to strengthen domestic research capacities for Bhutan's regenerative construction sector:

This thematic area expands Bhutan's capacity to generate evidence, test innovations, and commercialise regenerative construction solutions. Core priorities include improving research and testing infrastructure, launching an entrepreneurial accelerator for nature-based construction ventures, and advancing circular material flows. Strengthening technical knowledge and enabling new business models will position Bhutan at the forefront of regenerative construction innovation.

1. Advance regulatory reforms and policy initiatives to create enabling regulatory frameworks that support the uptake of regenerative planning and building practices:

This strategic pillar ensures that policy frameworks and regulatory systems actively enable the transition to a regenerative built environment. Key actions update the national building code to accommodate nature-based materials, legalise and regulate industrial hemp, and embed regenerative construction within wider national strategies. Improved health and safety standards and new monitoring and certification systems create clear rules for industry while strengthening accountability and quality assurance.

2. Harness urban growth and development projects – such as Thimphu-Paro and GMC – to catalyse value chains, diversified job opportunities, and direct investment flows towards regenerative construction:

The fourth area of focus establishes the financial conditions required to scale regenerative construction. Measures include establishing a national investment roundtable and advisory committee, designing blended public-private financing instruments, and offering targeted incentives for early adopters. Public procurement becomes a strategic driver, while regional and global climate funds help derisk early commitments.

3. Utilising local and global knowledge to build national capacities, expand skilling opportunities, and increase demand for nature-based building materials:

This field of action strengthens Bhutan's ability to advance regenerative construction in theory and practice. It focuses on market research to better understand demand and perceptions, integration of new construction principles into vocational and higher education, and development of high-visibility demonstration projects to prove feasibility at scale. At the same time, networks of practitioners and pioneers are amplified to accelerate knowledge exchange and sector-wide learning.

The roadmap's approach is integrative rather than sequential. Reliable data and research provide the foundation for evidence-based policymaking; regulatory clarity builds confidence for investment; financial instruments and procurement create predictable demand; and education and training ensure that new practices can be implemented safely and effectively. Each area reinforces the others, forming a feedback loop between policy, practice, innovation, and knowledge.

The intended outcome is a regenerative construction sector that operates with lower emissions, greater resource efficiency, and stronger domestic value creation. By improving technical standards, market incentives, and workforce skills, Bhutan can gradually replace imported, emission-intensive materials with locally sourced, nature-based alternatives, generate skilled employment, and enhance economic resilience. The roadmap positions regenerative construction not as a separate niche, but as an integrated component of Bhutan's broader economic, social, and environmental strategies.

List of Abbreviations

AAC	Annual Allowable Cut
AIT	Asian Institute of Technology
BDBL	Bhutan Development Bank Ltd.
BNB	Bhutan National Bank
CF	Community Forest
CGI	Corrugated Galvanised Iron
CST	College of Science and Technology
DHI	Druk Holding and Investments Ltd.
DoFPS	Department of Forests and Park Services
FMU	Forest Management Unit
FYP	Five Year Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GMC	Gelephu Mindfulness City
GNH	Gross National Happiness
GNHCB	Gross National Happiness Centre Bhutan
GPP	Green Public Procurement
GWP	Global Warming Potential
INBAR	International Network of Bamboo and Rattan
LBC	Laminated Bamboo Lumber
LCA	Life Cycle Assessment
LDC	Least Developed Country
LEDS	Low Emissions Development Strategy for Human Settlements
MoAL	Ministry of Agriculture and Livestock
MoEA	Ministry of Economic Affairs
MoENR	Ministry of Energy and Natural Resources
MoF	Ministry of Finance
MoICE	Ministry of Industry, Commerce, and Employment
MoIT	Ministry of Infrastructure and Transport
MoU	Memorandum of Understanding
NDCs	Nationally Determined Contributions
NEC	National Environment Commission
NRDCL	Natural Resources Development Corporation Ltd.
NSSC	National Soil Service Center
OHS	Occupational Health and Safety
PRL	Private Registered Land
R&I	Research and Innovation

RO	Regional Opportunity
RUB	Royal University of Bhutan
RCC	Reinforced Cement Concrete
SME	Small and Medium-sized Enterprises
SRFL	State Reserved Forest Land
T-Lab	Transformation Lab
THC	Tetrahydrocannabinol
TSP	Thimphu Structure Plan
UNDP	United Nations Development Program

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INTRODUCTION

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About ReBuilt

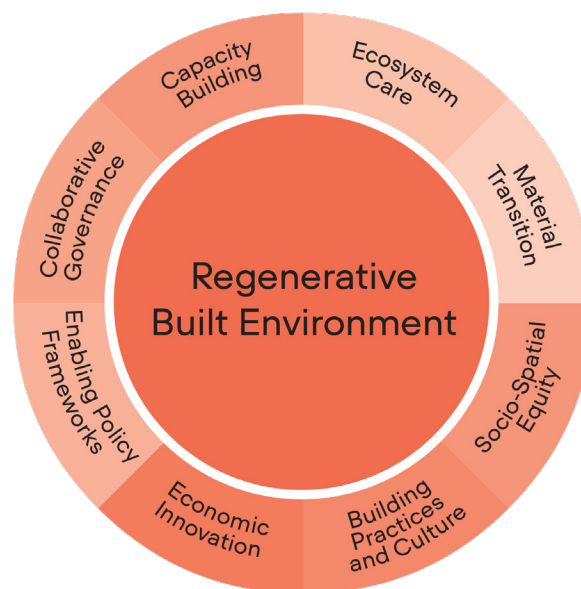
Regenerative Construction as a New Paradigm

The ReBuilt project – Transformation Pathways Towards a Regenerative Built Environment – envisions a fundamental shift in the global construction sector: from a major contributor to climate change to a carbon sink and a catalyst for ecological restoration and social well-being. By advancing the concept of a regenerative built environment, ReBuilt explores how buildings and cities can be designed, built, and maintained to reverse environmental damage.

Rethinking Materials and Practices

A central pillar of this transformation is the shift towards regenerative construction materials and practices. ReBuilt approaches this challenge by holistically engaging with bio-regional economies and their supply chains, considering their socio-spatial, ecological, and political contexts. The project advocates for the use of nature-based materials – such as wood, bamboo, hemp, and compressed earth blocks – as well as secondary materials like reused and recycled building components. These regenerative materials not only help lower carbon emissions but also support more circular, adaptive, and resilient construction systems worldwide.

Fig. 1.1:
Regenerative System Change
Framework including Key
Intervention Fields



Project Timeline and Funding

ReBuilt is funded by the German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety. The project runs from February 2023 to December 2025.

Key Intervention Fields

Transitioning towards a regenerative built environment requires targeted interventions across multiple scales and sectors. Therefore, the methodology of the project consists of eight key intervention fields (Fig. 1.1) that are adaptable entry points for action.

1. Ecosystem Care

Managing and restoring natural systems (forests, soils, landscapes) to ensure regenerative material sourcing, biodiversity enhancement, and ecological-social balance.

2. Material Transition

Enables a shift towards low-carbon, nature-based, and circular construction materials. It emphasises reducing embodied carbon, optimising resource use, and enhancing circularity through reuse, recycling, and design for disassembly.

3. Socio-Spatial Equity

Ensuring just and inclusive access to resources, regenerative spaces, and urban development while addressing historic inequities and promoting cultural heritage in the built environment.

4. Building Practices and Culture

Designing and constructing buildings that actively contribute to environmental and human well-being, using low-carbon materials, circular design principles, and net-positive impact strategies.

5. Economic Innovation

Creating new financial models, markets, and business strategies that support the scaling of regenerative materials and equitable local economies.

6. Enabling Policy Frameworks

Developing supportive legal, financial, and regulatory structures to create incentives, enforce standards, and drive systemic change across sectors and communities.

7. Collaborative Governance

Establishing participatory decision-making processes that engage multiple stakeholders, ensuring transparency, shared responsibility, and co-creation of material transition policies.

8. Capacity Building

Supporting communities, professionals, and institutions through education, training, and cross-sector collaboration to drive and sustain the transition to a regenerative built environment.

Scales and Systemic Transformation

A systemic and integrated approach across these four scales—global cooperation, regional bioeconomy, building adaptability, and material sustainability—is necessary for a transition towards a regenerative built environment.

1. Global Scale Provides overarching guidance and alignment through international agreements (e.g. the Paris Agreement), influencing carbon reduction, biodiversity conservation, and ethical resource use.

2. Regional & National Scale The regional level implements place-based solutions, activating bioeconomies and integrating historical, cultural, and ecological patterns into development. The national level enables this process through policy, regulation, and economic incentives.

3. Building Scale Buildings must shift from static structures to adaptive processes that interact with their surrounding socio-ecological systems.

4. Material Scale The selection of nature-based, circular materials is essential for regeneration. Sustainable sourcing, reuse, and recycling minimize environmental harm while supporting local economies and ecological restoration.

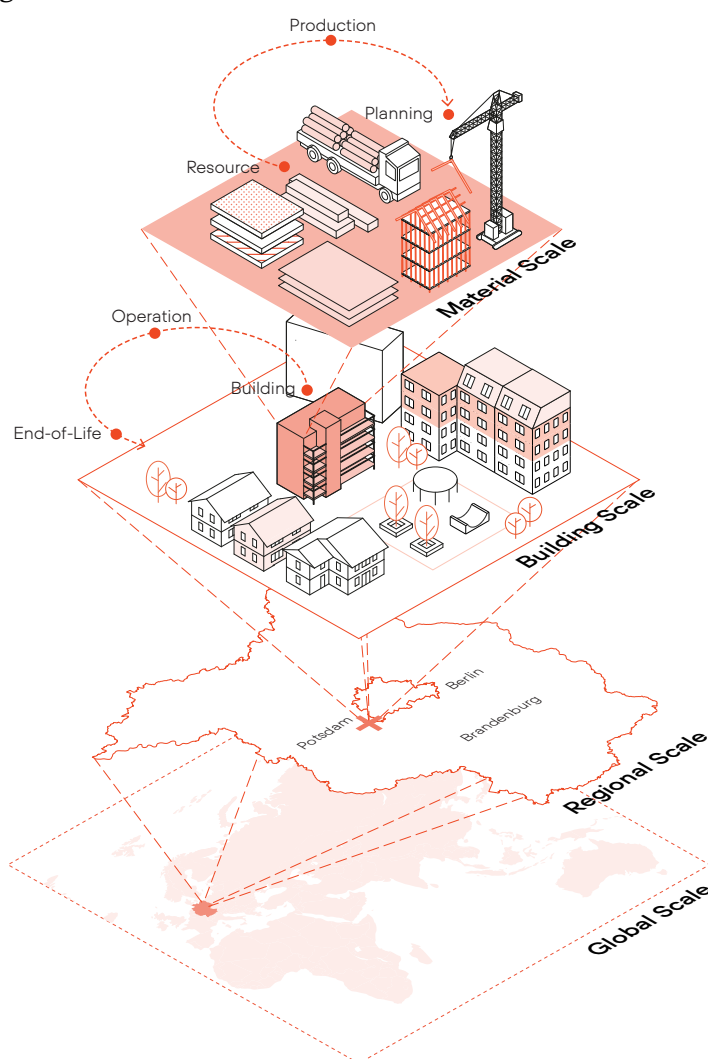


Fig. 1.2:
The systemic interlinking of different scales is beneficial to put the concept of a Regenerative Built Environment into practice

Leading the Way for Regenerative Futures

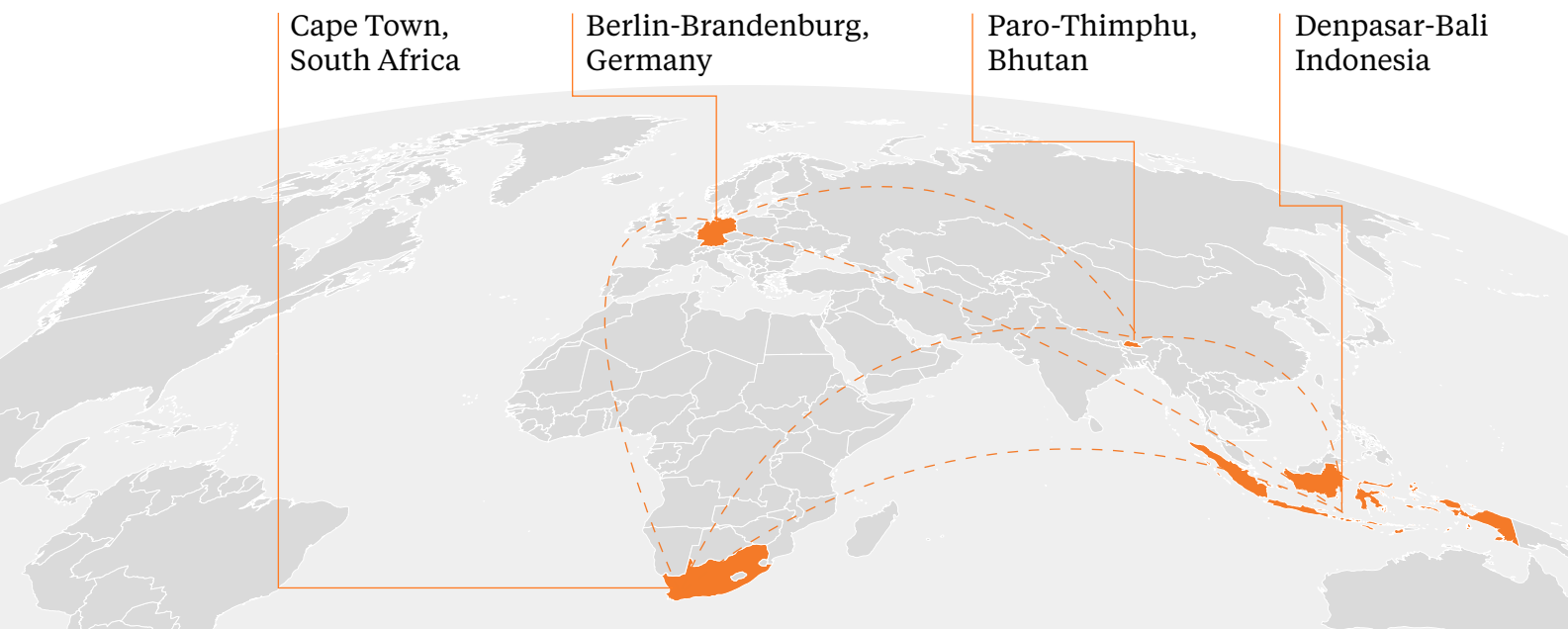
The ReBuilt Project has two research strands: a global study and a series of regional case studies. The Global Study quantifies the supply and demand of bio-based materials for future urban construction worldwide. A scenario-based model compares regional availability of timber resources with projected residential needs, generating spatially explicit insights into material substitution potential and carbon storage capacity. The four Regional Case Studies – Berlin-Brandenburg (Germany), Cape Town (South Africa), Denpasar-Bali (Indonesia), Paro-Thimphu (Bhutan) – promote transformative actions by engaging with local stakeholders, identifying opportunities, and testing them through demonstration projects.

The project aims to advance the adoption of regenerative building materials by combining quantitative assessments with qualitative field research at multiple scales. Our interdisciplinary and international team employs a variety of methods including lifecycle assessments, spatially explicit resource assessments, transformation labs, and participatory engagement. The results are disseminated in various multi-media formats. The global and regional strands of the project are in continuous dialogue to ensure solutions are both locally grounded and globally relevant.

Iterative and Integrated Research

Each case study explores region-specific opportunities and challenges for transitioning towards a regenerative built environment. In close collaboration with local stakeholders, ReBuilt develops actionable, context-sensitive pathways that inform policy recommendations, strategic roadmaps, and a digital toolkit to guide other city-regions undergoing similar transitions. ReBuilt's regional case studies follow a three-phase methodology:

1. **Systems Analysis:** Assessment of local regenerative materials, construction sector structures, socio-spatial conditions, policies, and actor networks essential for enabling change.
2. **Transformation Labs:** Participatory platforms where stakeholders co-create and test alternative futures, practices, and systemic solutions.
3. **Strategic Roadmaps:** Co-developed with local partners, focus on scalable strategies for short-, medium-, and long-term transition pathways.



Towards a Regenerative Built Environment

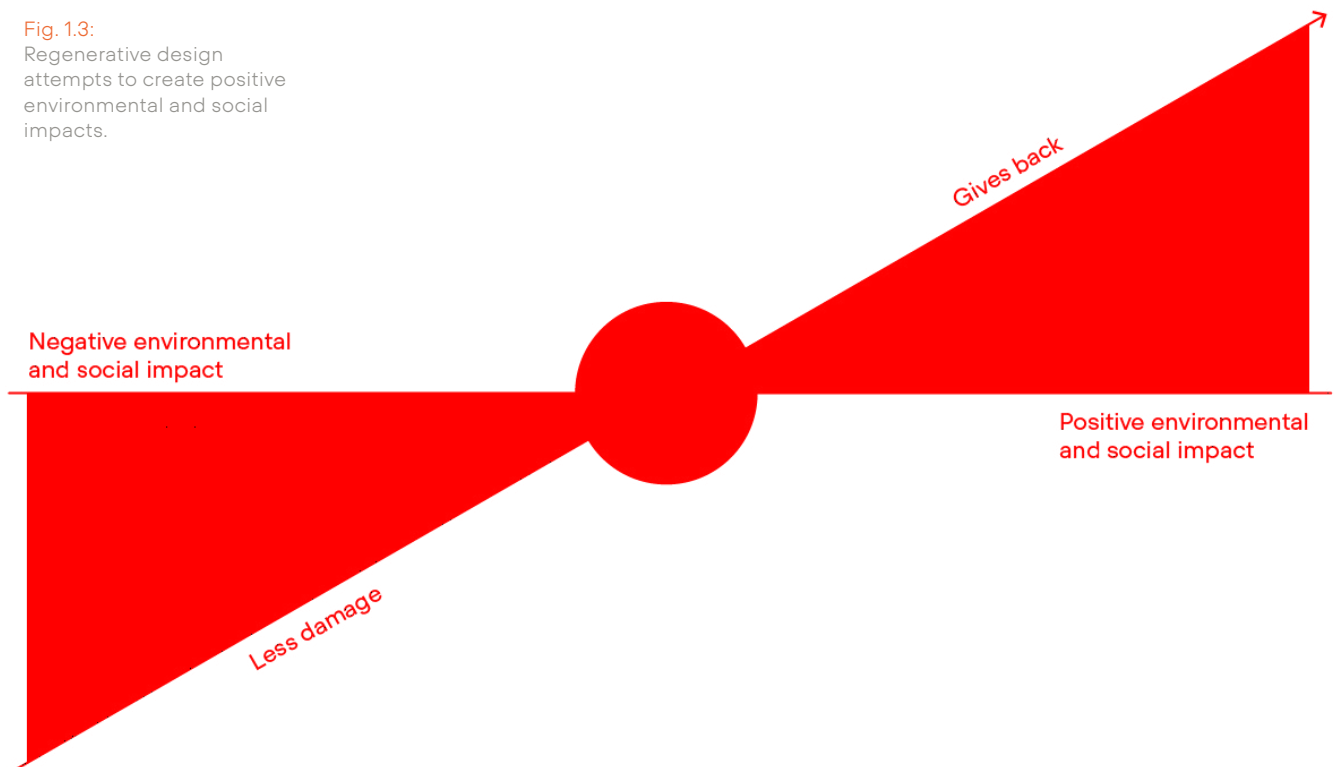
Rethinking construction from a climate liability into a force for positive change for planet and people

To meet future housing and infrastructure needs while helping to repair the ecosystems of our planet, we must move beyond sustainability ambitions towards regenerative development. Incremental improvements will not be enough. A fundamental shift is needed. The concept of a Regenerative Built Environment offers a guiding vision to support action and thinking that integrates socio-cultural and ecological systems – addressing both climate change and the broader polycrisis.

At its core, regenerative development seeks to create systems – buildings, neighbourhoods, and cities – that do more than reduce harm. These systems actively restore and regenerate natural environments, such as forests, soils, and landscapes. In this sense, a regenerative built environment promotes the synergistic co-repair of cities and ecosystems.

Regenerative development addresses the urgent need to limit extractive resource use while strengthening the capacity of socio-ecological systems to thrive. It goes beyond harm reduction, actively replenishing ecosystems and fostering more equitable, place-based futures. As such, regenerative construction can serve as a key driver of this shift – transforming the built environment from a carbon source into a force for positive change for both people and the planet.

Fig. 1.3:
Regenerative design
attempts to create positive
environmental and social
impacts.



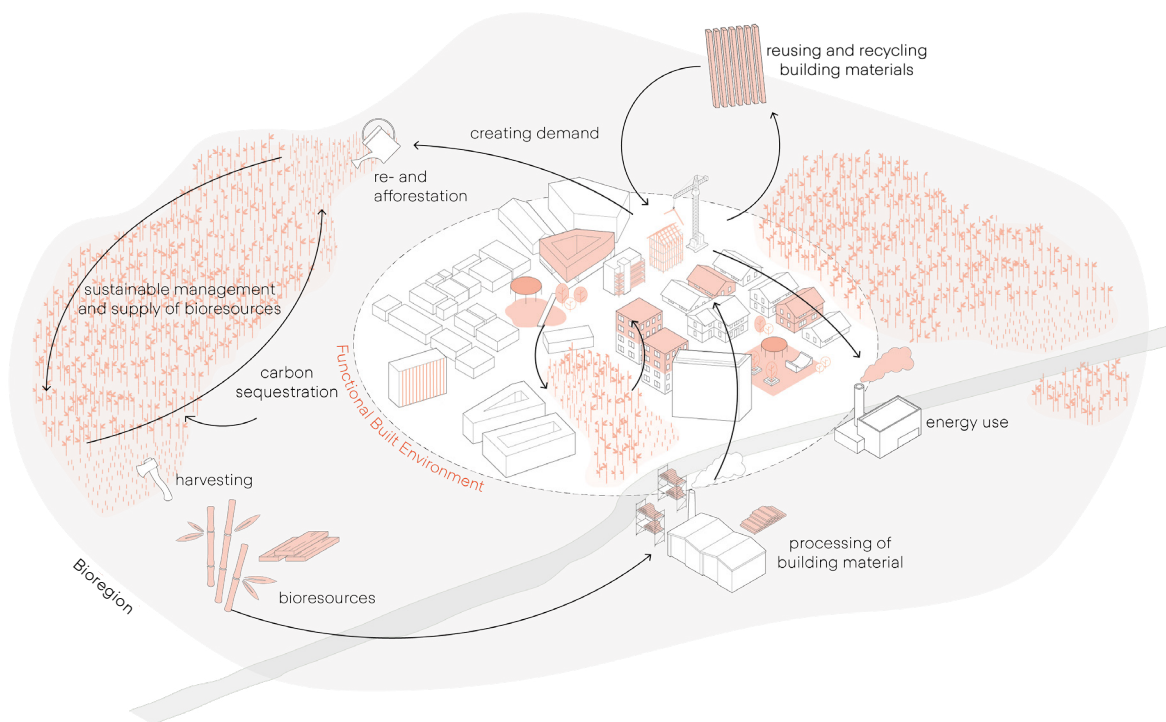
Activating the Regional Bioeconomy for Construction

The regenerative process starts at the macro scale (bioregions or landscapes) and extends down to local contexts emphasizing the importance of a historical, cultural, ecological, and economic understanding of both the places of sourcing and construction. While many urban sustainability efforts operate within administrative or infrastructural boundaries, regenerative thinking invites a shift towards bioregional frameworks – aligning human activity with ecological systems. This means focusing on regional material value chains, including their processes, human and non-human actors, and infrastructure as well as development dynamics, regulatory frameworks, and political directions.

Efforts to merely decarbonise the current palette of urban construction materials will not be sufficient to reverse the building sector's climate impact. While increasing the efficiency of steel and concrete production is important, this alone cannot achieve the deep reductions in both embodied and operational carbon emissions that are urgently needed. Regenerative construction, by contrast, prioritises regionally available, sustainably sourced, nature-based materials – including timber, bamboo, hemp, and earth – that offer

- **“Nature-based” solutions** grounded in carbon sequestration, substitution, and storage, transforming buildings and cities into long-term carbon sinks;
- The potential to **jump-start an economy** that channels investment into the restoration of forest ecosystems, enhancing their health, resilience, and broader ecological function;
- Support for **sustainable development** in both urban and rural areas by creating green jobs and delivering climate-adapted, healthy, and secure housing.

Fig. 1.4:
Bioregional thinking
connecting landscapes and
construction materials



Reader's Guide

This collaborative roadmap is designed to help readers understand not only what a regenerative transition requires, but how different parts of the system can work together to enable it. Rather than a chronological summary of research activities, it serves as a proposition that outlines strategic opportunities, actions, and pathways towards a regenerative future. The following guidance explains how to navigate this report efficiently and make the most of its structure.

1. Start With the System Readiness Overview

This section gives a concise understanding of the central challenges and opportunities identified through systems analysis and stakeholder engagements carried out by the ReBuilt project. Read this first if you want to understand why regenerative construction is needed and what system barriers must be overcome.

2. Move to the Vision and Target Goals

The Vision chapter translates the Systems Analysis into a future-oriented narrative: what a regenerative built environment should look like in each of the target regions, and what high-level goals guide the transition? Use this section to align your own organisational or sectoral ambitions with the wider national direction.

3. Consult the Timeline for an Overview of All Actions

All actions from across the roadmap are presented together on a single integrated timeline. This helps you see:

- When different interventions should begin,
- How short-, medium-, and long-term actions reinforce one another,
- Where synergies or dependencies exist between different Regional Opportunities.

4. Review the Key Intervention Fields and Spider Diagram

These sections summarise the roadmap's full set of actions across eight intervention fields, while the accompanying spider diagram visually illustrates their relative emphasis. Together, they offer readers a quick thematic overview of where change is most needed and how different priorities relate to one another.

5. Read Each Regional Opportunity (RO) as a Core Chapter

The ROs – strategic themes that identify where the greatest potential exists to shift the built environment towards a regenerative future – are the backbone of the roadmap. Each RO:

- Responds to a core systemic challenge identified through research and stakeholder engagement.
- Defines a promising leverage point where targeted interventions can create meaningful change.
- Provides a strategic direction, broad enough to guide a transition but specific enough to generate concrete actions.
- Connects multiple sectors and actors, helping align policies, markets, research, and cultural practices.
- Organises the roadmap vision: all actions, indicators, and collaborations are structured under the ROs.

Think of a Regional Opportunity as a strategic pathway – a bridge between high-level vision and practical implementation.

6. Use Cross-References to Understand System Interactions

These roadmap guidelines are designed as a systems tool. Actions in one RO (e.g., research infrastructure) often directly support actions in another (e.g., standards reform). Reading across chapters will help you understand how the roadmap functions as an integrated transition pathway rather than a set of disconnected interventions.

7. Use the Collaborative Roadmap recommendations as a Practical Decision-Making Tool

The structure enables you to:

- Identify relevant actions for your institution,
- Plan multi-year programmes,
- See system-wide dependencies,
- Coordinate with other stakeholders,
- And track progress through KPIs.

ReBuilt Thimphu-Paro

Background

Bhutan is a small, landlocked nation located in the Himalayan mountain range between China and India. The country has a total area of approximately 38,000 km² and holds vast natural resources, with close to 70% of its land cover classified as forest.¹ Its elevation ranges from about 160 m to 7,300 m above sea level (a.s.l.), cutting across several parallel ranges and eco-regions of the Himalayas.



Fig. 1.5:
Map of South Asia

Bhutan, a constitutional monarchy since 2008, has a population of almost 780,000 people, making it one of the least densely populated countries in the world, with about 21 people per square kilometre. While most of the population lives in rural areas and depends on forestry and agricultural activities, the larger cities – Thimphu, Paro, and Phuentsholing – are rapidly growing due to rural-to-urban migration.²

Bhutan is one of the few recognised carbon-negative countries in the world, owing to its extensive forest cover and hydropower-driven renewable energy sector. Alongside agriculture and forestry, hydropower and construction are among the largest contributors to the national economy.³

Bhutan is recognised for embodying people-centred and traditional values through its Gross National Happiness (GNH) philosophy. GNH is a normative framework that seeks to balance socio-economic advancement with environmental stewardship, cultural integrity, and good governance. This approach places equal emphasis on societal well-being and economic growth, embedding environmental conservation, cultural preservation, and good governance into national policy.

¹ Department of Surveying and Mapping (DoSAM), "Land Use Land Cover 2020," 2023, [Link](#).

² Sangay Chopel, "Population and Migration in Thimphu Thromde" (Thimphu: Journal of Bhutan Studies, Vol.41, 2019), [Link](#).

³ Department of Environment and Climate Change, "The First Biennial Transparency Report from the Kingdom of Bhutan to the UNFCCC" (Thimphu, 2024), [Link](#).

In 2008, Bhutan transitioned from an absolute monarchy to a democratic constitutional monarchy following the voluntary abdication of the Fourth King. This political transformation marked a critical juncture in the institutionalisation of participatory governance and by the constitutional entrenchment of GNH principles.

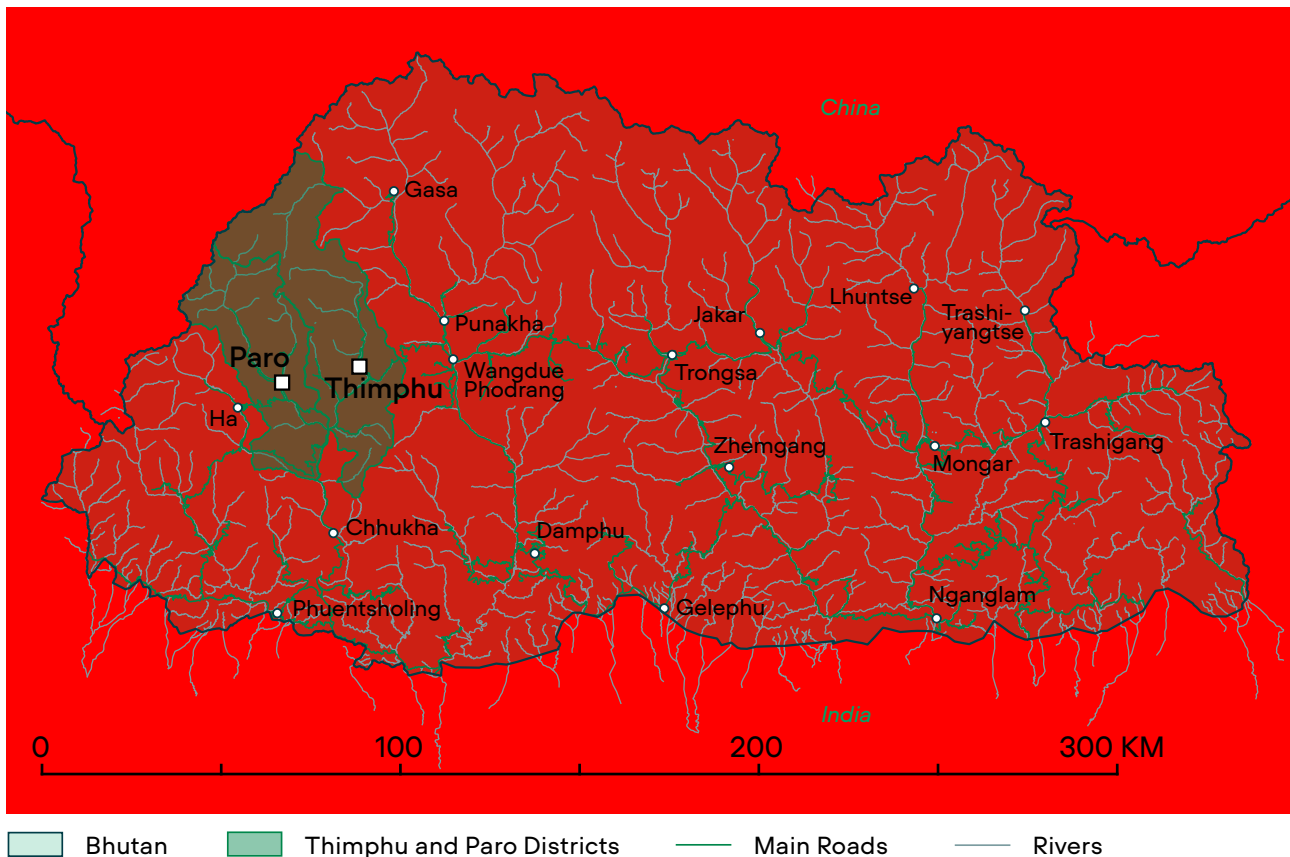


Fig. 1.6:
Map of Bhutan

Bhutan is a well-respected voice in international nature conservation and sustainability debates and offers a unique model of inclusive development strategies. Its capital city, Thimphu, has expanded from 8km² to 26km² over the last 20 years,⁴ accompanied by rapid population growth of 3.72%.⁵ This urbanisation has placed immense pressure on land, housing, infrastructure, and public services. The recently updated Thimphu Structure Plan – a strategic urban planning document – projects a population increase of at least 66,000 people over the next 25 years, creating growing demand for new housing and infrastructure in the city.⁶

Additionally, the Gelephu Mindfulness City (GMC) development at the southern border – envisioned to be built using nature-based materials and to eventually host up to one million citizens – is creating momentum and expanding demand for nature-based building materials.

Considering these developments, Bhutan represents a highly relevant case study of rapid urbanisation and its associated challenges in South Asia and beyond. Given the country's commitment to carbon-neutral development and its abundant natural resources, there is significant potential for Bhutan to leverage these assets to build a regenerative construction sector and set a global example for sustainable building practices grounded in social and environmental stewardship.

⁴ Bhutan Ecological Society, "Enabling an Energy Efficient Built Environment in Bhutan" (Thimphu: Bhutan Ecological Society, 2018), 1, [Link](#).

⁵ Sangay Chopel, "Population and Migration in Thimphu Thromde" (Thimphu: Journal of Bhutan Studies, Vol.41, 2019), 114, [Link](#).

⁶ Ministry of Infrastructure and Transport (MoIT) et al., "Thimphu Structure Plan 2023-2047" (Thimphu, 2023), 21.

ReBuilt's Activities in Thimphu-Paro

As part of the ReBuilt project, a series of research activities were undertaken in Bhutan to assess and advance the potential of regenerative and nature-based construction practices. This included a comprehensive systems analysis examining the status quo of the domestic construction sector, the availability of nature-based materials, and the structure of associated value chains. A public survey was conducted to understand the perceptions of nature-based construction, alongside a policy landscape review to evaluate regulatory opportunities and constraints.

Six multi-stakeholder workshops – engaging representatives from government, the private sector, forestry, spatial planning, academia, the construction industry, civil society, and citizens – served as the foundation for identifying key barriers and enablers to the uptake of regenerative practices and for collaboratively shaping strategic directions.



Fig. 1.7:
Stakeholder workshop at the
T-Lab in Thimphu
©Tino Imsirovic, 2024



Fig. 1.8:
Hempcrete prototyping at the
T-Lab in Thimphu
©Tino Imsirovic, 2025

In-depth explorations of locally available materials such as timber, hemp, bamboo, and earth were central to assessing their potential within Bhutan's unique socio-environmental context. Collaborative efforts included a technical partnership with the Asian Institute of Technology (AIT) in Thailand to test the mechanical properties of Bhutanese timber species, informing the potential integration of timber into national building codes. Additionally, a comprehensive technical guide for hemp-based construction was developed in collaboration with the Bauhaus Earth laboratory for material experimentation.

A hands-on workshop with the Tarayana Foundation further demonstrated practical applications of nature-based construction through the co-production of hemp-lime and hemp-earth blocks using locally sourced materials. Research visits and a study on the engineered bamboo sector in the region were also carried out, exploring the vast potential of bamboo as a regenerative building material.

Building on these participatory and research-driven insights, this roadmap was co-developed with local stakeholders, outlining context-appropriate regional opportunities and concrete actions to support Bhutan's transition towards a regenerative built environment.

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System Readiness

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Department of Environment and Climate Change, "Bhutan's Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy (LTS)" (Thimphu, 2023), 2, [Link](#).

8

Peter Ellis and Mark Roberts, *Leveraging Urbanization in South Asia: Managing Spatial Transformation for Prosperity and Livability* (Washington, DC: World Bank, 2015), [Link](#).

9

Jumana Alaref et al., "Bhutan Labor Market Assessment Report," 2024, 45, [Link](#).

10

Royal Government of Bhutan, "Thirteenth Five Year Plan" (Thimphu, 2024), 39, [Link](#).

Overall Problem Statement

Over the last decades – like many emerging economies – Bhutan has had to pivot its development priorities towards economic growth and prosperity to provide opportunities and high living standards to its growing youth population. This has inevitably resulted in increasing domestic emissions and energy consumption. In fact, Bhutan's carbon-neutral status could be at risk as early as 2047–2048 under a business-as-usual pathway.⁷

Having experienced one of the fastest rates of urbanisation and population growth in South Asia in recent decades,⁸ the construction sector now has a significant opportunity to help mitigate emissions linked to urban expansion and economic development, given its central role in the national economy. Considering Bhutan's long-standing commitment to environmental conservation and social protection, a transition towards a regenerative construction sector could offer multi-layered benefits that support both its development objectives and its traditional cultural philosophies.



Fig. 2.1:
Urban street life on Norzin
Lam, Thimphu
©Kéan Koschany, 2024

11

Leishipem Khamrang, "Bhutan's Dream City of Thimphu," *South Asia Research* 40, no. 3 (September 1, 2020): 1–19, [Link](#).

12

National Statistics Bureau (NSB), "Bhutan Living Standards Survey 2022" (Thimphu, 2020), [Link](#).

Rural-to-Urban Migration as a Driver of Rapid Urban Growth in the Thimphu-Paro Region

Bhutan has experienced high rates of rural-urban migration in recent years, with 60% of internal migrants moving to urban areas in search of better socio-economic opportunities,⁹ and Thimphu receiving the highest number of migrants at 59,578 up to 2017.¹⁰ Compared to 15% in 1999, 39% of the population resided in urban areas in 2022,^{11,12} and the urban population is projected to increase to about 57% by 2050.¹⁰



Fig. 2.2:
Construction site of a RCC
frame building in Thimphu
©Kéan Koschany, 2024

The expected urban expansion is occurring primarily in Thimphu, whose population is nearly five times that of the next-largest urban centre, Phuntsholing.¹³ The city already accounted for over 42% of the total urban population in 2017 and recorded a housing demand-supply gap of over 14,000 units in 2021.¹⁴ The recently established Thimphu Structure Plan (TSP), a guiding strategic urban planning document for the capital region, projects an additional 66,160 people moving to the city over the next 25 years, further accelerating the demand for new housing and infrastructure.¹⁵

Emission-Intensive, Extractive Material Practices Shape the Domestic Construction Sector

Emissions from construction both stem from the energy used during building operations and from the embodied energy in building materials resulting from their extraction, processing, transport, and disposal. Although Bhutan has abundant natural resources and a rich tradition of nature-based construction, the country's construction industry currently relies heavily on carbon-intensive materials such as cement, concrete, fired bricks, and steel.

Around 75% of these materials are imported from India,¹⁶ leading to high transport emissions and creating environmental impacts along their supply chains within Bhutan and beyond. Although detailed estimates of construction-related GHG emissions in Bhutan are not yet available, sectors associated with the built environment – such as manufacturing and construction, transport, and cement production – accounted for over 50% of total domestic GHG emissions in 2022.¹⁷

¹³ National Statistics Bureau (NSB), "Population Projections Bhutan 2017-2047" (Thimphu, 2019), [Link](#).

¹⁴ Ugyen M. Tenzin, "Report on Housing Market Demand Survey" (Asian Development Bank, 2021), 21, [Link](#).

¹⁵ Ministry of Infrastructure and Transport (MoIT) et al., "Thimphu Structure Plan 2023-2047" (Thimphu, 2023), 21.

¹⁶ Tshering Pelden, "Nu 21.26 Bn Spend on Import of Construction Materials – Business Bhutan," *businessbhutan.bt*, July 25, 2023, [Link](#).

¹⁷ Department of Environment and Climate Change, "The First Biennial Transparency Report from the Kingdom of Bhutan to the UNFCCC" (Thimphu, 2024), 62, [Link](#).



Fig. 2.3:
Timber depot of a FMU in
Bumthang
©Kéan Koschany, 2024

Lack of a Robust Domestic Construction Sector and Competitive Nature-Based Value Chains

Despite Bhutan's commitment to sustainable development, the absence of a robust and competitive domestic construction sector continues to limit the country's ability to translate this ambition into practice – particularly in the built environment. Bhutan's heavy reliance on imported materials and labour reflects a broader structural weakness in domestic capacity and value-chain development.

Conventional, emission-intensive materials are predominantly imported from India, and the construction workforce is largely foreign, with almost 90% of workers being non-Bhutanese.¹⁸ This external dependency results in high construction costs, restricts local employment opportunities, and hinders knowledge transfer to the domestic workforce. As external actors shape contemporary construction practices in Bhutan, the involvement and competitiveness of the domestic private sector remain weak.

While Bhutan's vast natural resources hold significant potential for regenerative construction, key nature-based materials – such as timber, bamboo, hemp, and earth – remain underutilised due to fragmented or undeveloped value chains.

Timber is sourced domestically, but its supply chain is not yet equipped to deliver products at the scale required for the rapidly growing urban centres. Similarly, earth-based techniques such as rammed earth remain largely confined to rural areas, with no scalable processes to support their application in urban settings. Bamboo is currently limited to low-value uses

18

Roderick Wijunamai, "Migrant Construction Workers in Bhutan: Understanding Immigrant Flows and Their Perceptions," *Rig Tshoe* – Research Journal of the Royal Thimphu College 3, no. 1 (September 2020): 46–57, [Link](#).

such as scaffolding and cladding, and engineered bamboo products are not yet available in the domestic market. Hemp grows widely across the country, yet strict regulations prevent the development of hemp-based construction products.

Bhutan currently lacks a supportive financial and market ecosystem to advance nature-based value chains. Although national policies strongly emphasise sustainable and low-carbon development, the specific mechanisms needed to channel investment into regenerative construction remain underdeveloped. Existing construction markets and financing systems are largely oriented towards conventional materials, which continue to dominate due to established standards, predictable cost structures, and greater confidence among lenders and developers



Fig. 2.4:
A contemporary urban
residential building in
Thimphu
©Kéan Koschany, 2024

Absence of Enabling Policies and Regulations for Regenerative Building Practices

Although initial efforts have been made, Bhutan’s regulatory and policy landscape has yet to establish a truly enabling environment for regenerative building practices. The country’s Green Building Guideline provides a valuable starting point by outlining principles for environmentally conscious design and construction. The “Low Emissions Development Strategy for Human Settlements” (LEDS,2018)¹⁹ identifies the promotion of alternative building materials – such as replacing clay bricks with autoclaved aerated concrete blocks, wood, and rammed earth – as an important long-term lever for GHG mitigation.

However, nature-based materials remain largely absent from binding regulatory frameworks, including building codes and technical standards. This lack of formal recognition and guidance significantly limits their widespread adoption in mainstream construction practices.

¹⁹
Ministry of Works and Human
Settlement (MoWHS), “Low
Emission Development Strat-
egy for Human Settlement”
(Thimphu, 2021), [Link](#).

Hemp, in particular, remains under strict regulation despite growing widely in the wild and showing potential as a regenerative building material. Cultivation for industrial purposes is not yet legal, and no policies currently support its commercial use in construction. More broadly, there are no technical benchmarks to assess the performance, safety, or energy efficiency of buildings constructed with nature-based materials. This regulatory gap not only deters investment and innovation but also perpetuates low awareness among stakeholders about the potential of regenerative construction.



Fig. 2.5:
Wild growing Cannabis
plants in Bumthang
©Kéan Koschany, 2024

Perception and Awareness as Barriers to Transformation

Perceptions around regenerative construction in Bhutan are evolving. While unfamiliarity with nature-based building materials still limits their widespread application, there is a growing openness among architects, engineers, contractors, and policymakers to explore more sustainable and locally rooted approaches to construction. Stakeholders increasingly recognise that regenerative building practices align with Bhutan's socio-ecological development goals and express willingness to adopt these practices once reliable data, financial support, and technical standards are in place.

Nevertheless, concerns and limited knowledge persist about the durability, maintenance requirements, and suitability of nature-based construction materials under Bhutan's diverse climatic and seismic conditions – both within planning departments and regulatory bodies, as well as among design and construction professionals. These uncertainties are often reinforced by the limited availability of accessible, context-specific performance data, ongoing questions about safety, longevity, and scalability, and the absence of visible demonstration projects.

While some actors in both the private and public sectors remain unaware of the potential of bio-based materials and value chains – and continue to associate contemporary construction with imported, emission-intensive materials – this perception is gradually shifting. The challenge lies in channeling these emerging aspirations into confidence and practice by strengthening literacy around regenerative construction across sectors and within society at large.

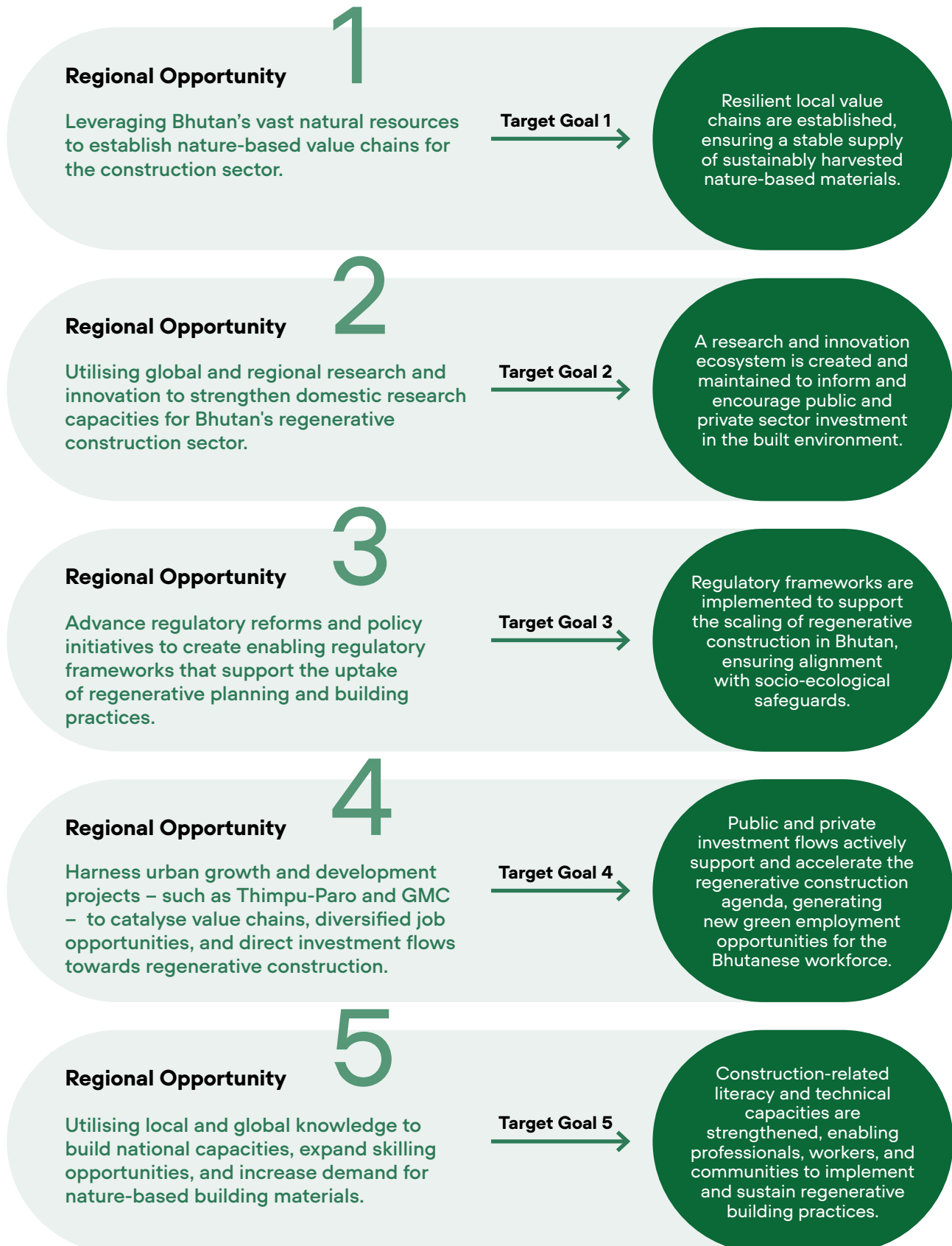
Vision



Bhutan leads the transition towards a carbon-neutral, socially inclusive, economically thriving, and culturally grounded construction sector by championing regenerative and nature-based building practices.

Bhutan envisions a regenerative construction sector that seamlessly blends local wisdom, scientific insight, and innovation. By harnessing its natural resources, strengthening nature-based value chains, building human capacities, and enabling supportive policies, the country can cultivate a built environment that is high-performing, low-impact, and culturally rooted. Through strategic urban projects and integrated knowledge systems, green jobs are created, innovation is accelerated, and investments are directed effectively. In doing so, Bhutan advances a socially inclusive, economically vibrant, and ecologically regenerative transition – transforming aspiration into tangible, place-based impact.

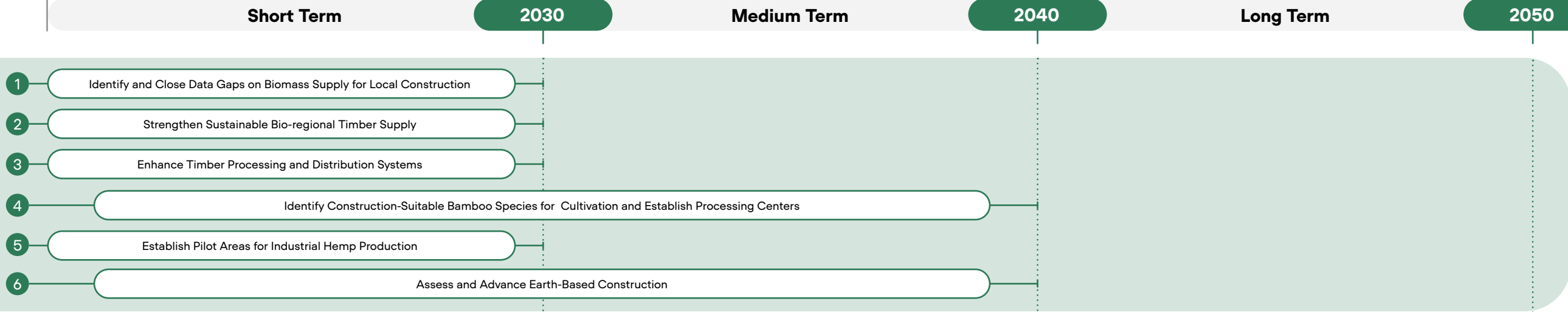
Target Goals and Regional Opportunities



Timeline

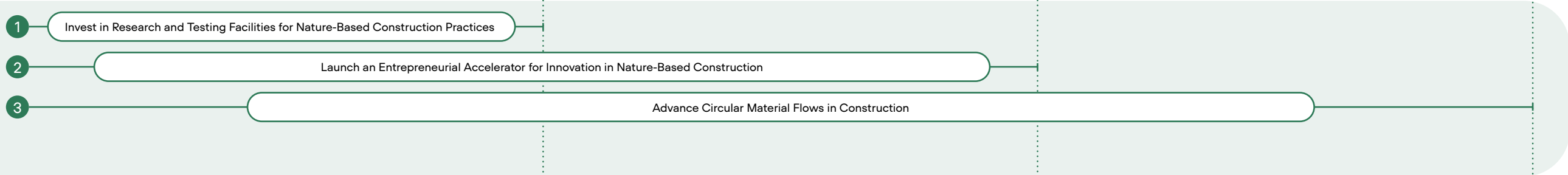
Regional Opportunity 1

Leveraging Bhutan's vast natural resources to establish nature-based value chains for the construction sector.



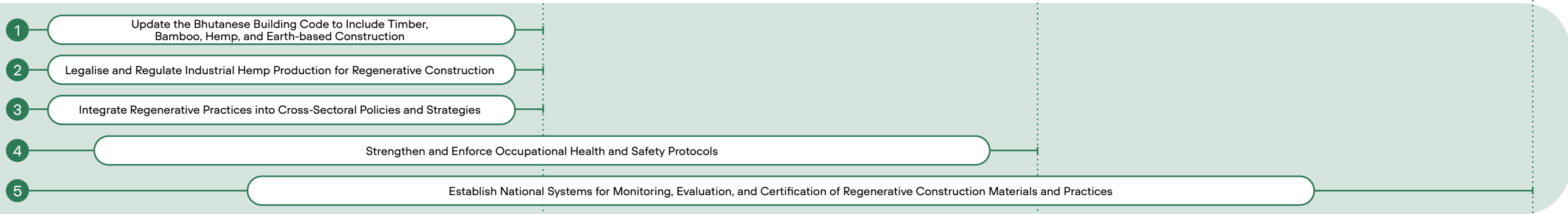
Regional Opportunity 2

Utilising global and regional research and innovation to strengthen domestic research capacities for Bhutan's regenerative construction sector.



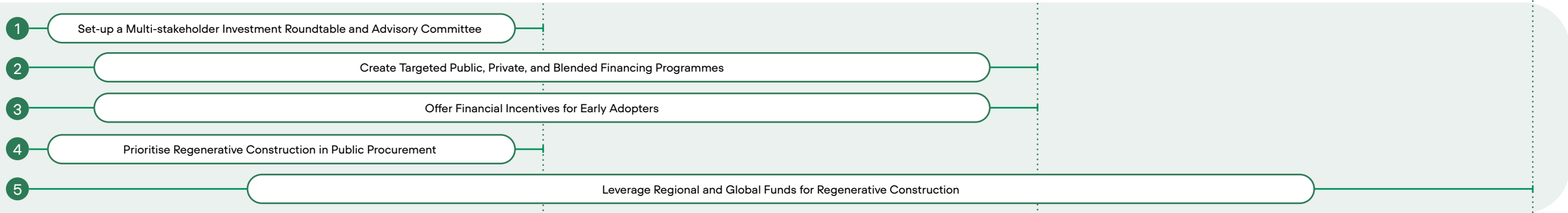
Regional Opportunity 3

Advance regulatory reforms and policy initiatives to create enabling regulatory frameworks that support the uptake of regenerative planning and building practices.



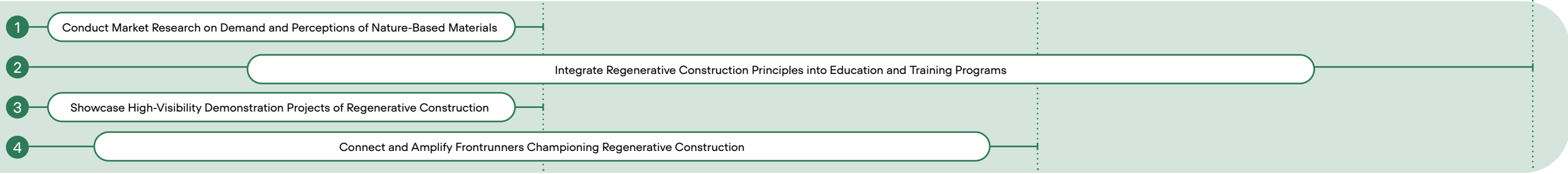
Regional Opportunity 4

Harness urban growth and development projects – such as Thimpu-Paro and the Gelephu Mindfulness City – to catalyse value chains, diversified job opportunities, and direct investment flows towards regenerative construction.



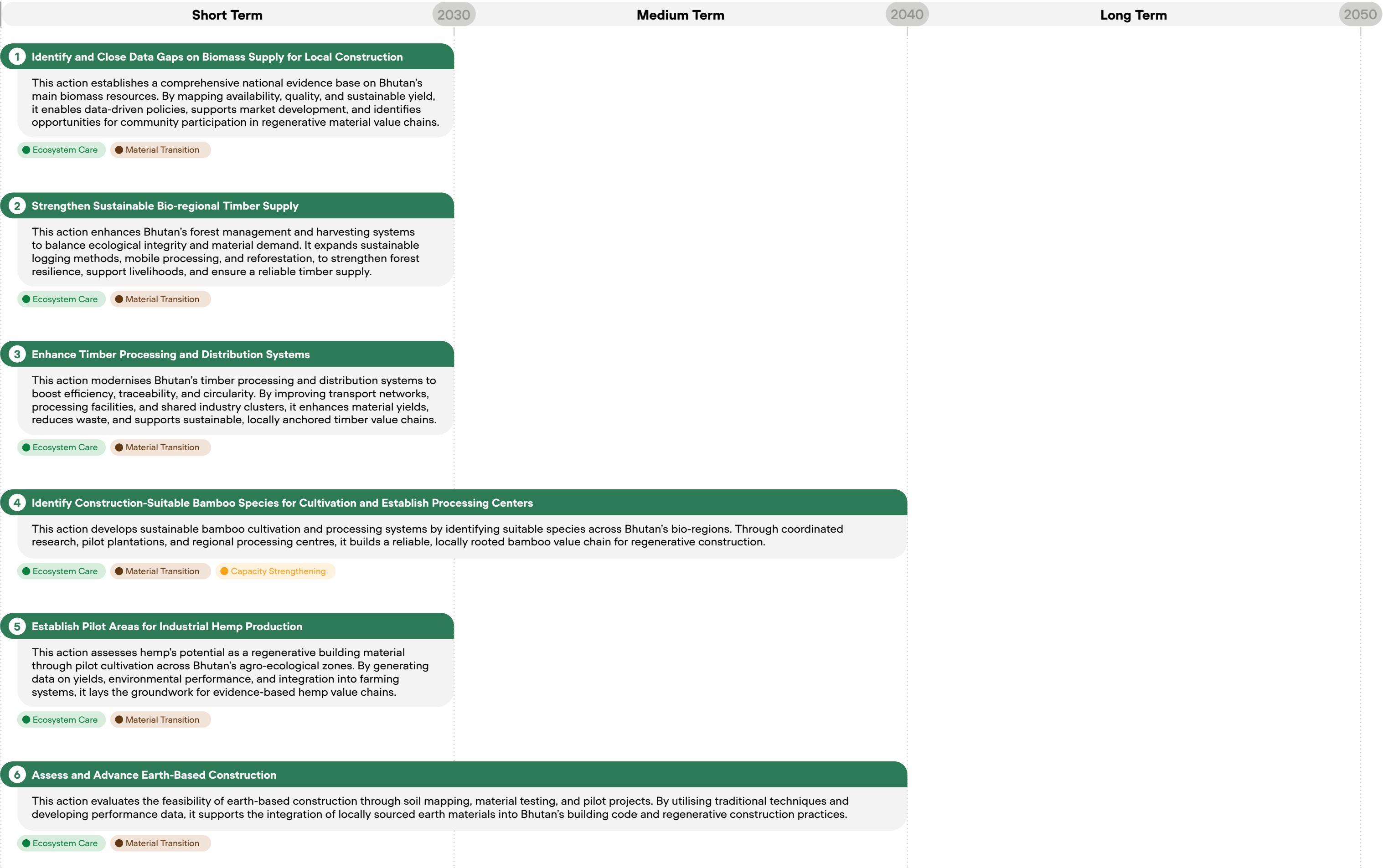
Regional Opportunity 5

Utilising local and global knowledge to build national capacities, expand skilling opportunities, and increase demand for nature-based building materials.



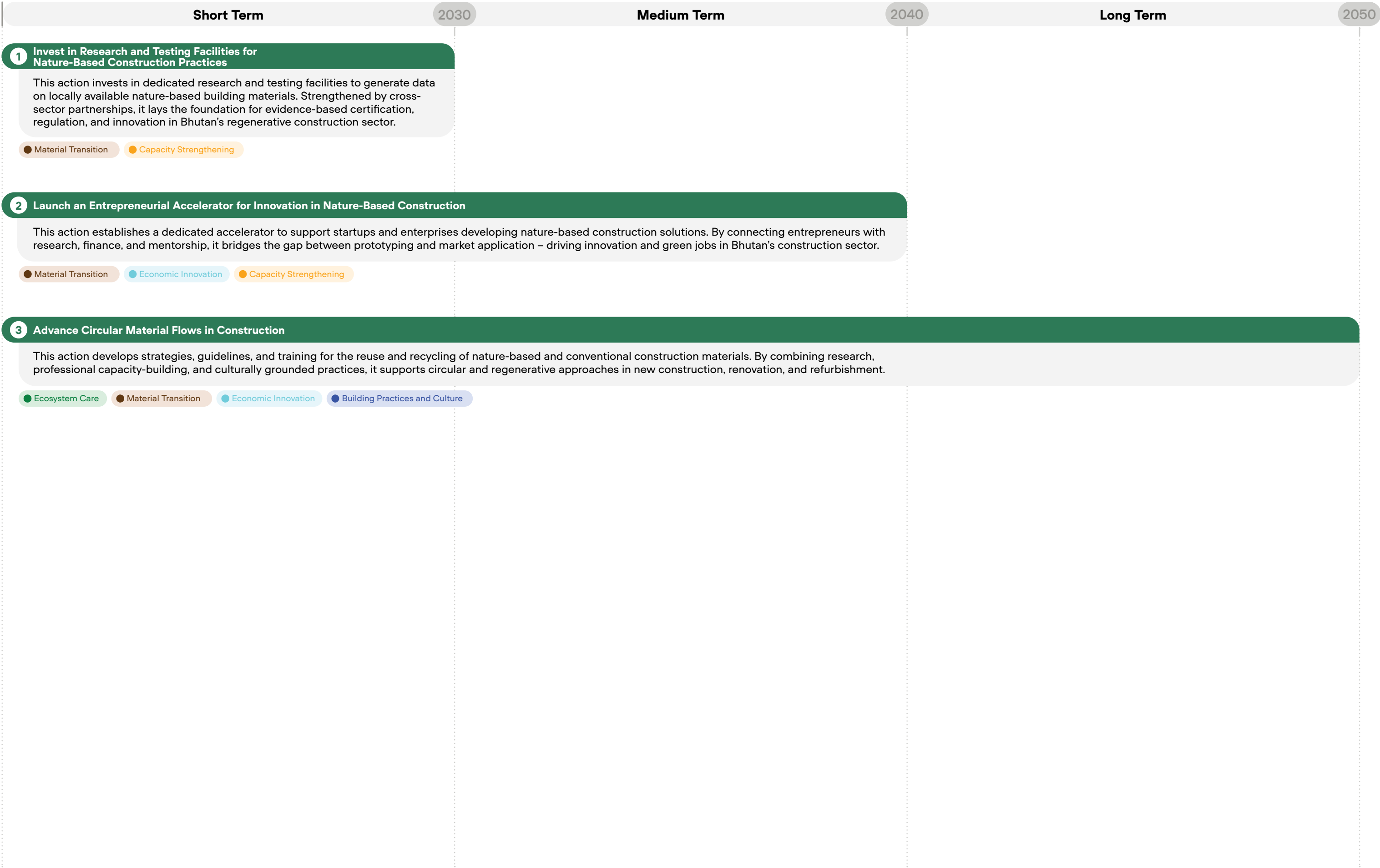
Regional Opportunity 1

Leveraging Bhutan’s vast natural resources to establish nature-based value chains for the construction sector



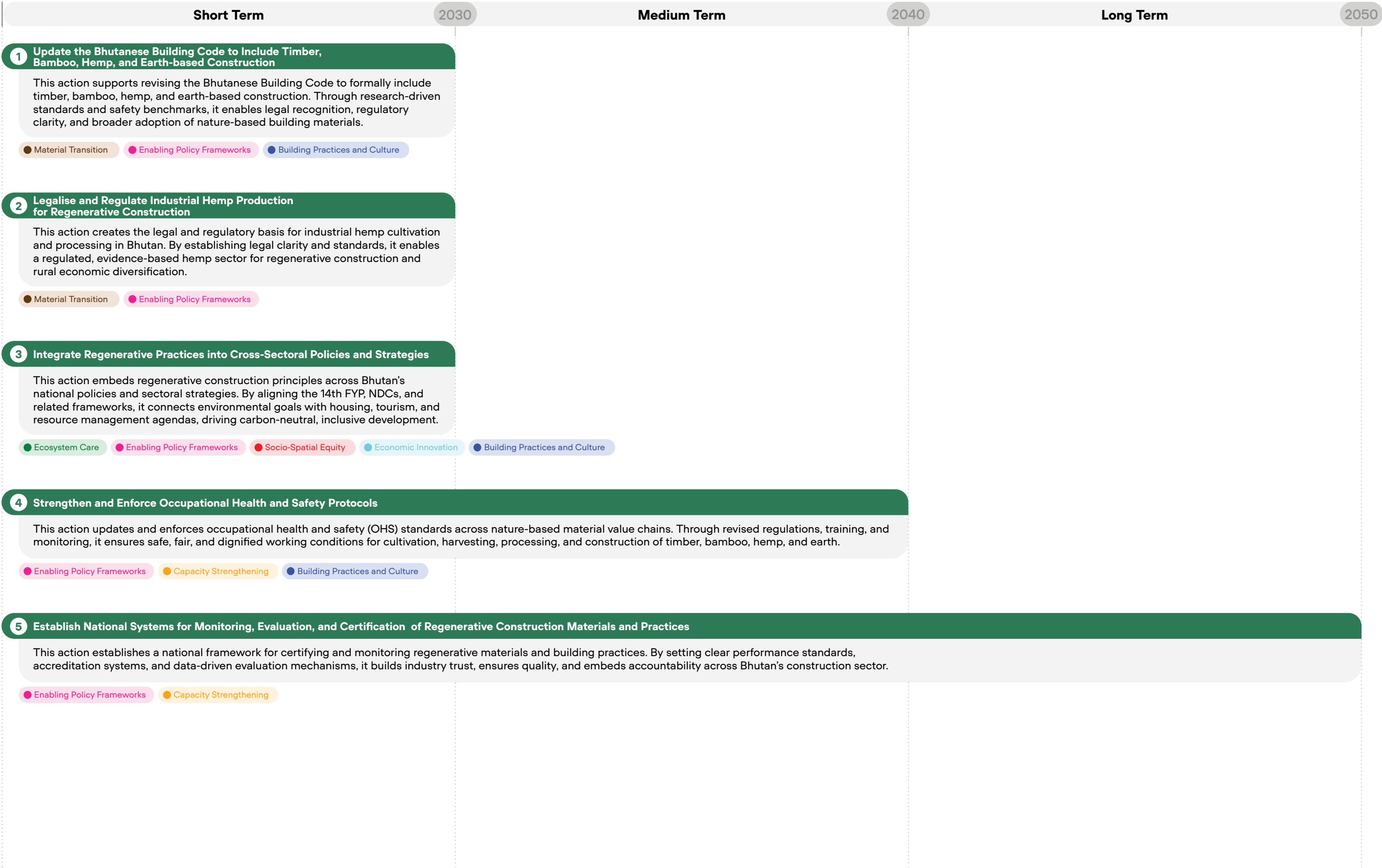
Regional Opportunity 2

Utilising global and regional research and innovation to strengthen domestic research capacities for Bhutan's regenerative construction Sector



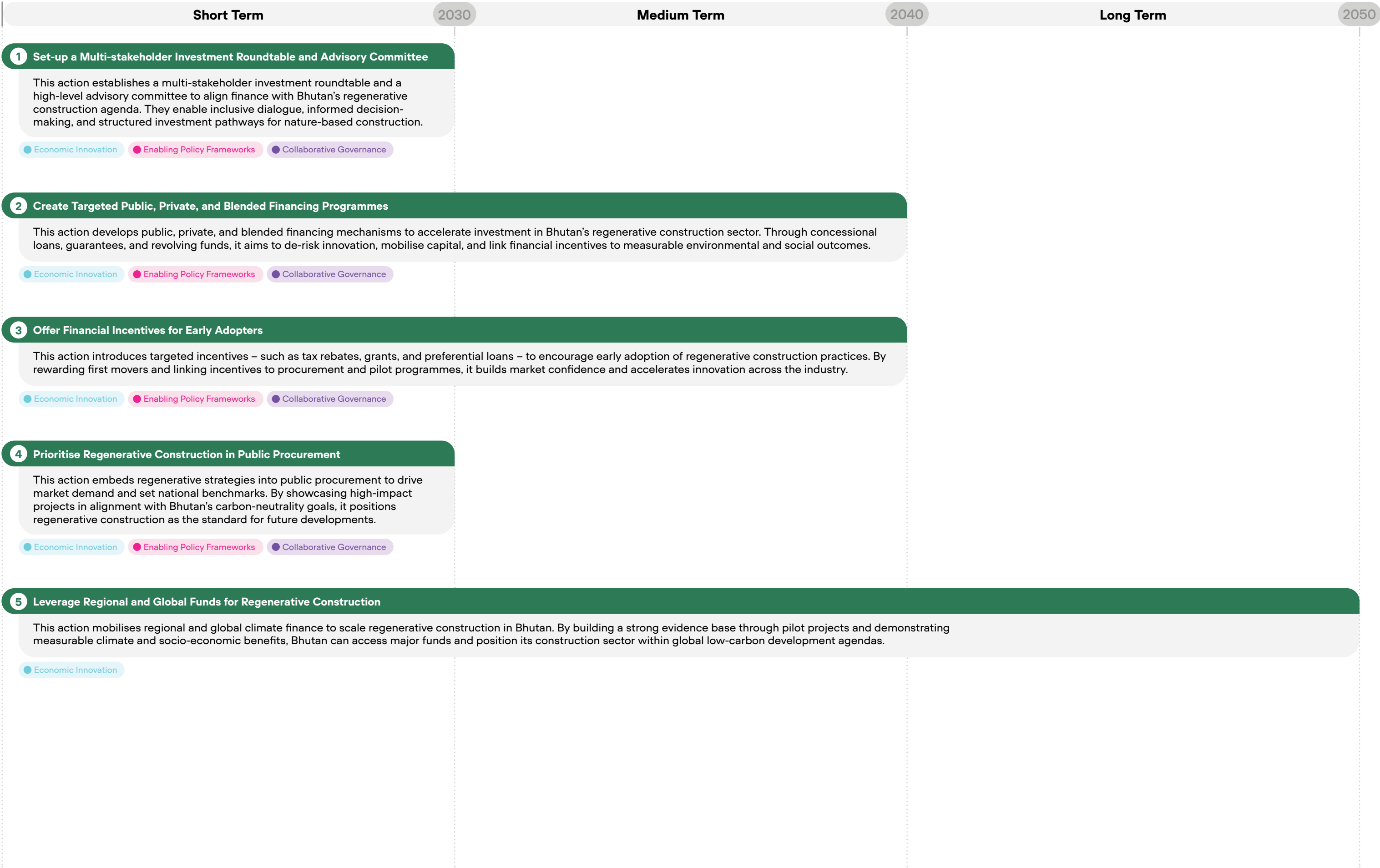
Regional Opportunity 3

Advance regulatory reforms and policy initiatives to create enabling regulatory frameworks that support the uptake of regenerative planning and building practices



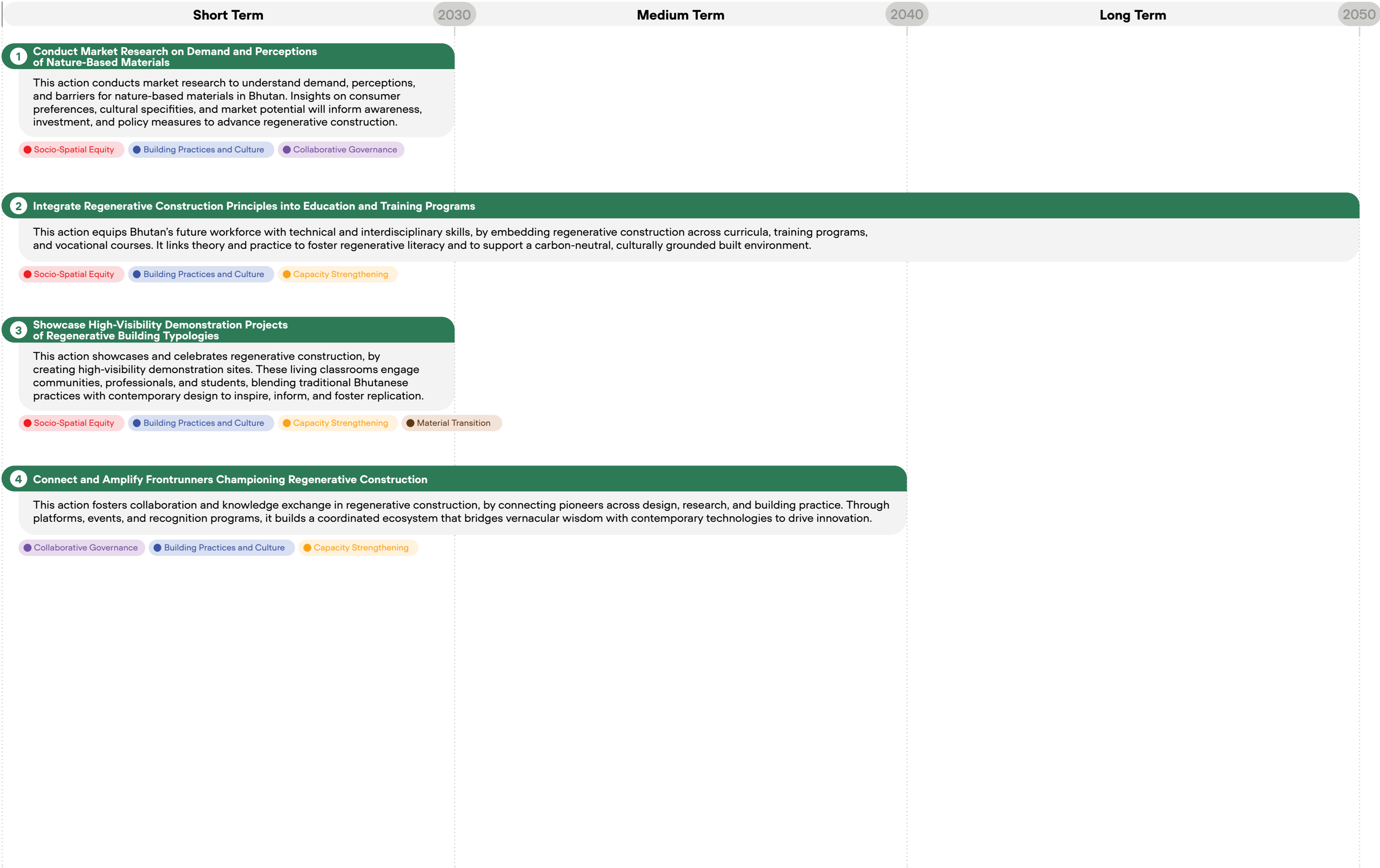
Regional Opportunity 4

Harness urban growth and development projects – such as Thimphu-Paro and the Gelephu Mindfulness City – to catalyse value chains, diversified job opportunities, and direct investment flows towards regenerative construction



Regional Opportunity 5

Utilising local and global knowledge to build national capacities, expand skilling opportunities, and increase demand for nature-based building materials



Spider Diagram

The spider diagram provides an overview of how the actions proposed in the roadmap are distributed across the eight intervention fields, illustrating which fields received the greatest emphasis and how different dimensions of the transition reinforce one another.

In Bhutan, 'Material Transition' emerged as the most significant field of intervention, reflecting the country's vast bioresources and the local relevance of advancing nature-based material value chains, improving technical standards, enabling circular flows, and increasing domestic value creation. This aligns with one of Bhutan's core challenges: the need to reduce reliance on imported and emission-intensive construction materials while developing robust, low-carbon supply chains for timber, bamboo, hemp, and earth. 'Ecosystem Care', 'Building Practices and Culture', 'Economic Innovation', and 'Capacity Building' are the next most prominent fields, highlighting that material transitions must go hand in hand with environmental stewardship, regenerative design, construction practices, new financing models, and a skilled workforce capable of advancing nature-based construction and innovation.

'Enabling Policy Frameworks' is another significant field of action related to the need for regulatory clarity, standardisation, and long-term policy certainty that would build investor confidence and guide industry decisions. Actions under the field 'Collaborative Governance' reflect the importance of multi-stakeholder coordination across ministries, research institutions, private actors, and civil society, emphasising shared responsibility in national development. 'Socio-Spatial Equity' has fewer actions, but its principles are embedded throughout the roadmap, such as ensuring that regenerative construction generates regional employment, supports inclusive urban development, and strengthens cultural continuity. Overall, the distribution indicates a transition strategy that is broad-based, systemic, and deliberately balanced across ecological, technical, institutional, and social dimensions.

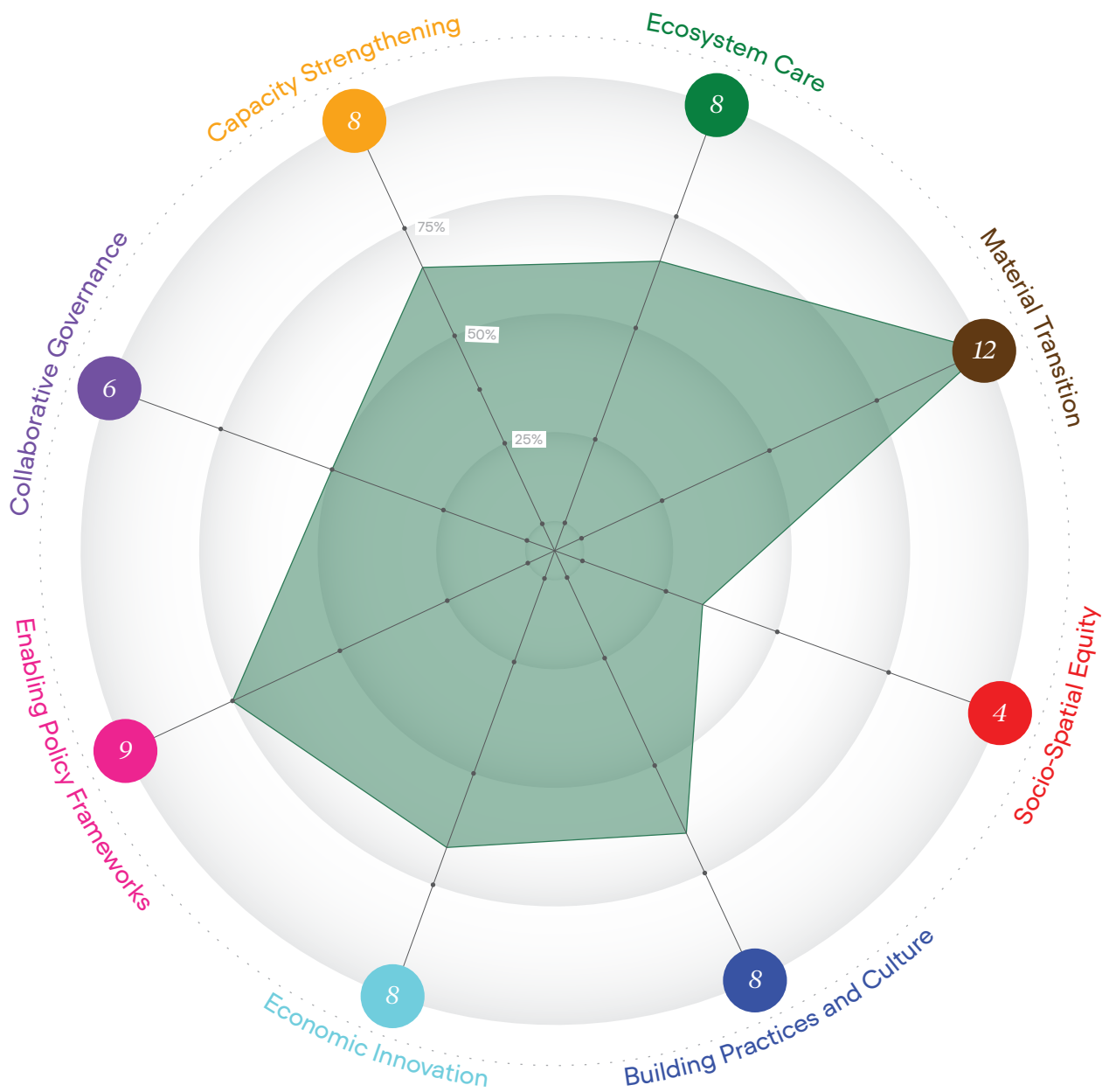


Fig. 2.7:
Spider Diagram

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Regional Opportunity 1



Fig. 3.1:
Community Forest, Paro
© Bas Princen for Bauhaus Earth, 2024

Leveraging Bhutan's vast natural resources to establish nature-based value chains for the construction sector

Background and Problem Statement

Bhutan's rapid urbanisation and expanding infrastructure development are reshaping the country's settlement patterns and material demand. Against this backdrop, the construction sector stands as both a major economic driver and a key opportunity for emissions reduction. The sector contributed about 7.7 % of Bhutan's GDP in 2023 and is closely linked to high-emitting industries such as cement production and transport, which together accounted for more than half of domestic greenhouse-gas emissions in 2022.^{20, 21} Aligning future construction growth with Bhutan's national ambition for carbon-neutral and regenerative development has therefore become an urgent priority.

Traditionally, Bhutanese settlements were built using locally available, renewable materials such as timber, earth, and stone – community based, regionally adapted, low-impact construction methods.^{22, 23} In contrast, contemporary urban construction – particularly in the Thimphu-Paro region – relies heavily on reinforced concrete, fired bricks, and steel. These materials are highly emission-intensive: in a typical mid-rise residential building in Thimphu, cement accounts for roughly 50% of embodied CO₂, bricks 25%, and steel 23%.²⁴ About 75% of these materials were imported from India in 2023,²⁵ a dependency that further increases both financial costs and environmental impact, as the landlocked country is fully reliant on road transport.

Nevertheless, Bhutan holds substantial potential for a transition towards locally anchored, nature-based construction. Nearly 70% of its land area remains under forest cover,²⁶ providing a strong resource base for sustainably managed timber, while fast-growing materials such as bamboo and hemp, as well as long-established traditional materials like earth, are also regionally available. Although efforts among governing bodies and institutions are increasing – such as the Ministry of Industry, Commerce, and Employment (MoICE) outlining concrete steps to improve the timber value chain²⁷ – these materials remain largely unutilised and lack robust value chains capable of supporting current and projected urban construction demand.

Across all these materials, systemic barriers persist – including limited data on resource availability and construction potential, a lack of enabling policies and regulations, insufficient infrastructure for testing and processing, and weak coordination between forestry, research institutions, and construction industry actors. These structural gaps prevent promising local nature-based materials from advancing into certified, market-ready products and hinder confidence among builders, policymakers, and investors in transitioning towards regenerative construction practices in Bhutan.

20

National Statistics Bureau (NSB), "National Account Statistics 2024," 2024, 19, [Link](#).

21

Department of Environment and Climate Change, "The First Biennial Transparency Report from the Kingdom of Bhutan to the UNFCCC" (Thimphu, 2024), 62, [Link](#).

22

Alexis Anne Bennett, "Tradition, Quality, Housing, Development : A New Paradigm for Urban Bhutan," Mit.edu (Masters Thesis, 2002), [Link](#).

23

Mark F. Jentsch et al., "Field Study of the Building Physics Properties of Common Building Types in the Inner Himalayan Valleys of Bhutan," *Energy for Sustainable Development* 38 (June 2017): 48–66, [Link](#).

24

Jigme Thinley and Sirimas Hengrasmee, "Assessment of Cost and Sustainability of Building Materials in Residential Buildings of Bhutan," *International Journal* 18 (2024): 482–91, [Link](#).

25

Tshering Pelden, "Nu 21.26 Bn Spend on Import of Construction Materials – Business Bhutan," *businessbhutan.bt*, July 25, 2023, <https://businessbhutan.bt/nu-21-26-bn-spend-on-import-of-construction-materials/>, [Link](#).

26

Department of Surveying and Mapping (DoSAM), "Land Use Land Cover 2020," 2023, [Link](#).

27

Ministry of Industry, Commerce and Employment (MoICE), "Industrial Development Roadmap of Bhutan" (Thimphu, August 2025), [Link](#).

Project Findings

Seeking to reduce emissions in the built environment, the MoIT has identified the promotion of alternative building materials as one of the key measures to mitigate carbon emissions in its Low Emission Development Strategy (LEDS) 2021.²⁸

During the ReBuilt project, a life cycle assessment (LCA) was carried out comparing a conventional typical urban mid-rise building in Thimphu (Fig.3.2) with a nature-based version. The study estimates a reduction in global warming potential (GWP) of up to 60% for the nature-based building – constructed with timber, hempcrete, and earth blocks – compared with the conventional version built with RCC frames, brick infill, and CGI-sheet roofing.²⁹



Fig. 3.2:
A typical residential midrise building in Thimphu was used for the LCA calculations

Another study from the ReBuilt project estimated the construction demand from Thimphu City until 2050 and assessed the GWP of meeting this demand with nature-based buildings. The findings indicate that a business-as-usual pathway of city growth and expanding floor area per person could generate between 4.3 MtCO₂e and 6.5 MtCO₂e of emissions from construction. If nature-based materials were used to meet this demand, emissions would drop by almost 74%. However, it should be noted that this is dependent on 100% use of nature-based materials for construction as well as a shift towards more compact urban growth and smaller floor area per capita. Nonetheless, even modest substitutions of nature-based materials for conventional materials were found to reduce emissions from construction.

These findings highlight the significant potential of locally available nature-based building materials – timber, bamboo, hemp, and earth – which ReBuilt identified as most relevant for supporting Bhutan's transition towards a regenerative construction sector.

²⁸ Ministry of Works and Human Settlement (MoWHS), "Low Emission Development Strategy for Human Settlement" (Thimphu, 2021), [Link](#).

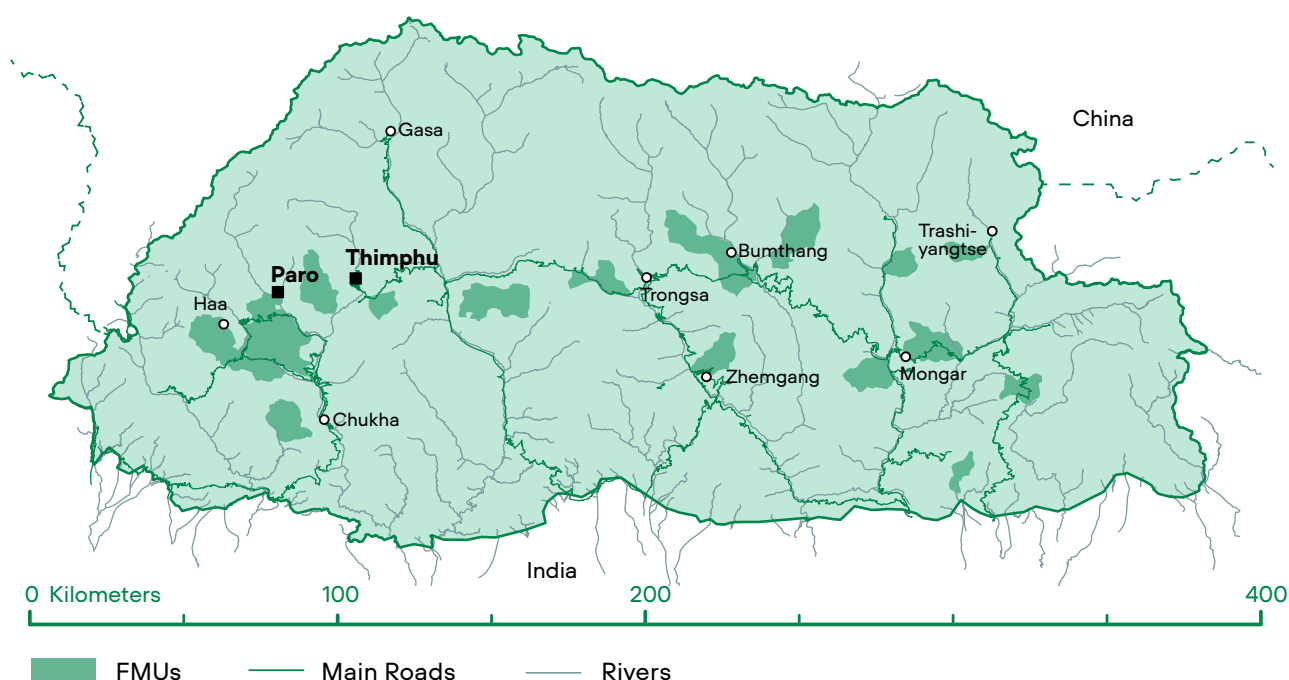
²⁹ Alisa M. Schneider et al., "Carbon Mitigation Potential in Building Design: A Region-Specific LCA Approach for Nature-Based Construction," (paper in press) (Sustainable Built Environment Conference, Zurich, 2025).

Timber Value Chains

Timber represents the most immediately scalable pathway for Bhutan to transition towards regenerative and low-emission construction. When harvested and processed sustainably, timber serves as both a renewable building material and a carbon sink – storing carbon in buildings while allowing forests to sequester additional carbon as they regenerate. Beyond traditional log or frame systems, engineered and prefabricated timber solutions further expand the possibilities of contemporary construction, offering improved structural performance, fire resistance, and construction speed, while maintaining a lower embodied-carbon footprint than conventional materials. Combined with Bhutan’s longstanding tradition of rural timber construction, these advantages position timber as a natural entry point for advancing regenerative building practices in the country.

Bhutan’s forests offer a strong foundation for this transition. Approximately 70% of the country’s land area is classified as forest. Of this, around 20% (542,347 ha) is managed forest, with about 16% considered suitable for sustainable management. Commercial timber is sourced from 21 Forest Management Units (FMUs) under the Department of Forests and Park Services (DoFPS), supported by community forests (CFs), local forest management groups, and private registered land (PRL). In 2024, almost 295,131 m³ of timber was extracted out of which 77% was designated for commercial use.³⁰

Fig. 3.3:
Locations of FMUs in Bhutan



Bhutan’s forestry governance is guided by robust conservation policies, such as the Forest and Nature Conservation Act, which ensure that extraction remains within ecological limits. However, a combination of stringent conservation mandates, steep terrain, and limited infrastructure constrains the volume of timber that can be harvested economically and safely.

30
Forest Monitoring and Information Division (FMID), “Annual Forestry Statistics 2024” (Thimphu, 2025), [Link](#).

While timber remains integral to Bhutanese construction – used for structural frames, roofing, joinery, and interior finishes – its application in urban construction remains limited. As Bhutan aims to actively reduce emissions through the use of nature-based building materials, there is significant potential to leverage its renewable resource base for regenerative construction.

Although Bhutan currently lacks an industrialised timber industry, the foundations for such a sector are beginning to take shape. The recently announced collaboration between Druk Holding and Investments Ltd. (DHI) and the College of Science and Technology (CST) to establish the country’s first structural timber testing facility signals growing institutional commitment to timber-based construction. Additionally, the establishment of mass timber plants is envisioned within the scope of the GMC development.³¹



Fig. 3.4:
Loading of timber logs in a
FMU in Bumthang
© Bas Princen for Bauhaus
Earth, 2024

³¹
“GMC to Establish Nu 1 Bn
Mass Engineered Timber Fac-
tory,” The Bhutanese, April 19,
2025, [https://thebhutanese.
bt/gmc-to-establish-nu-1-bn-
mass-engineered-timber-fac-
tory/](https://thebhutanese.bt/gmc-to-establish-nu-1-bn-mass-engineered-timber-factory/), [Link](#).

³²
Department of Forests and
Park Services (DoFPS), “Export
Potential for Wood Products,
Establishment of Mega Wood
Processing Unit & Possible
Import Substitution in Bhutan,”
ResearchGate (Thimphu,
Bhutan, 2020), [Link](#).

Yet Bhutan’s existing timber value chain remains underdeveloped and geographically fragmented. Harvesting and transport are often challenging due to the country’s mountainous terrain, limited road access, and seasonal disruptions during the monsoon. Current practices rely on manual tree selection supported by satellite imagery, with logs transported individually by cable systems to the nearest forest road before being trucked to depots or sawmills. These conditions restrict log length and limit the production of high-grade, large-dimension products.

Mechanisation remains low, and most of Bhutan’s roughly 440 wood-based industries are small-scale furniture workshops and sawmills with limited processing capacity.³² As a result, significant portions of harvested wood are lost during felling and milling, and opportunities to use by-products such as

sawdust and offcuts remain largely untapped. End-of-life pathways for timber are also underexplored. The absence of modern drying, grading, and treatment facilities further constrains product quality and market competitiveness.



Fig. 3.5:
Private saw mill in Bumthang
© Bas Princen for Bauhaus
Earth, 2024

Institutional fragmentation and the lack of coordinated value-chain planning further exacerbate these challenges. Responsibilities for forest management, harvesting, and commercial distribution are divided among multiple actors, often without systematic alignment of objectives or data exchange. Certification, traceability, and quality-assurance mechanisms have yet to be established, creating uncertainty for both domestic builders and potential export markets.

Bamboo Value Chain

Bamboo represents one of Bhutan's most promising resources for establishing a regenerative construction industry. Its fast 3-5 year growth cycle, high carbon sequestration rates (6–18 Mg ha⁻¹ yr⁻¹),³³ and ability to regenerate annually after only three to four years make it an ideal candidate for regenerative construction.³⁴ When properly cultivated and processed, bamboo can provide durable, lightweight, and structurally efficient materials for housing, interiors, and infrastructure. The International Network for Bamboo and Rattan (INBAR) has already identified bamboo as a highly suitable nature-based material in Bhutan's context.³⁵ Its use in construction could help ease harvesting pressures on natural forests while contributing to Bhutan's climate goals and creating income opportunities for rural communities.

33
Tommaso Chiti, Emanuele Blasi, and Maria Vincenza Chiriaco, "Carbon Sequestration in a Bamboo Plantation: A Case Study in a Mediterranean Area," *Journal of Forestry Research/Journal of Forestry Research* 35, no. 1 (February 24, 2024), [Link](#).

34
Rashmi Manandhar, Jin-Hee Kim, and Jun-Tae Kim, "Environmental, Social and Economic Sustainability of Bamboo and Bamboo-Based Construction Materials in Buildings," *Journal of Asian Architecture and Building Engineering* 18, no. 2 (March 26, 2019): 1–11, [Link](#).

35
Oliver Frith et al., "Bamboo Construction in Bhutan: A Feasibility and Market Study," INBAR.int (INBAR, 2015), [Link](#).

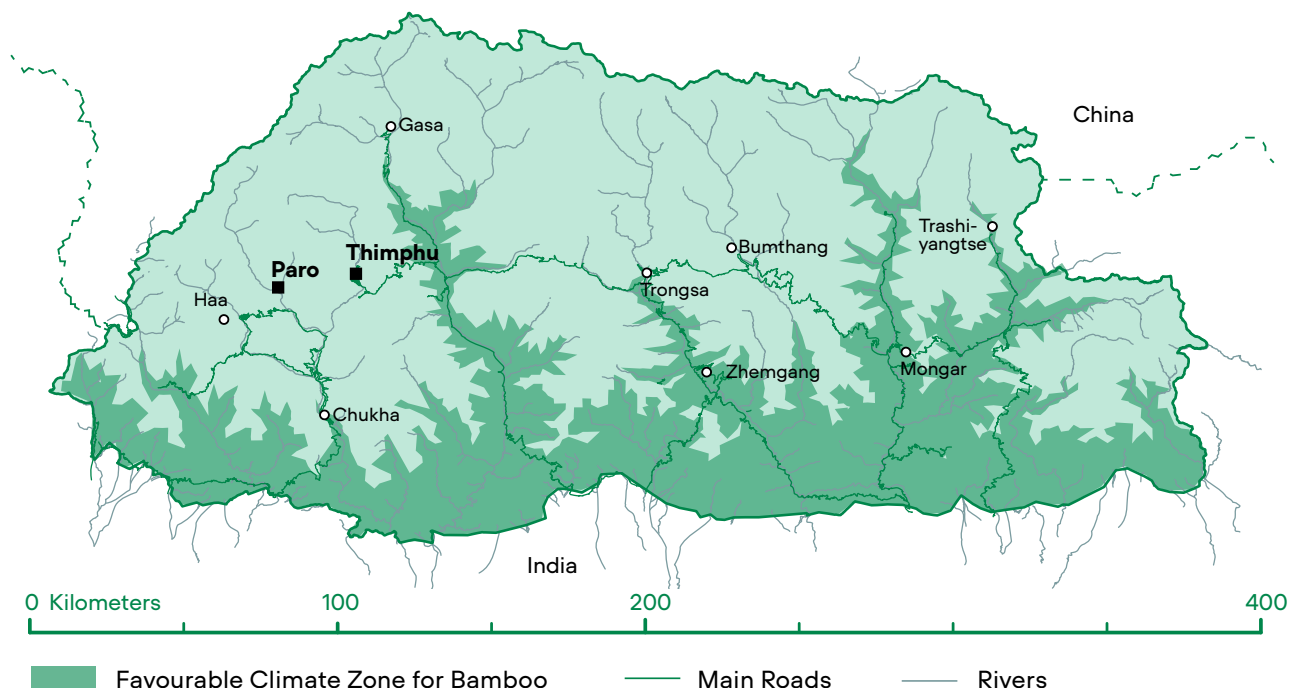


Fig. 3.6:
Favorable climate zone for
bamboo

36
Jambay Jambay and Pinkey Dahal, "Bamboo Diversity Assessment and Its Relationship with Soil Properties in Sarpang, Bhutan," *Journal of the Bhutan Ecological Society* 1, no. 5 (April 2023), [Link](#).

37
Ministry of Economic Affairs (MoEA), "Report on Import Substitution Possibilities" (Thimphu, Bhutan, 2019), 18.

Bhutan hosts at least 15 genera and 33 native species of bamboo, naturally thriving in the southern and subtropical zones where climatic and soil conditions are favourable for cultivation.³⁶ Despite this ecological suitability, the material's potential remains largely untapped. Bamboo is primarily used for handicrafts, edible shoots, and fodder, while its application in construction is mostly limited to scaffolding and low-grade rural buildings.

In 2019, the Ministry of Economic Affairs (MoEA) reported that Bhutan imported more than one million euros' worth of bamboo annually – mainly from India – highlighting the lack of domestic cultivation and processing capacity.³⁷ Stakeholders confirmed this dependence, noting that although bamboo is culturally familiar, the absence of local treatment and processing facilities prevents its use at structural scale.

Fig. 3.7 (left):
Raw bamboo poles used as
scaffolding
© Kéan Koschany, 2024

Fig. 3.8 (right):
Raw bamboo poles used
as support for concrete
formwork
© Tino Imsirovic, 2024



Nevertheless, demonstration projects across the country have illustrated its feasibility, reducing timber demand by half and lowering overall construction costs by up to 50 percent.³⁸ These examples underscore its technical viability and social value as an affordable, low-carbon building material. Additionally, bamboo's high resistance to lateral stress and high strength-to-weight ratio makes it suitable for earthquake-resistant construction.³⁹

38

Oliver Frith et al., "Bamboo Construction in Bhutan: A Feasibility and Market Study," INBAR.int (INBAR, 2015), [Link](#).

39

Jan Bredenoord, "Bamboo as a Sustainable Building Material for Innovative, Low-Cost Housing Construction," *Sustainability* 16, no. 6 (January 1, 2024): 2347, [Link](#).

40

Rashmi Manandhar, Jin-Hee Kim, and Jun-Tae Kim, "Environmental, Social and Economic Sustainability of Bamboo and Bamboo-Based Construction Materials in Buildings," *Journal of Asian Architecture and Building Engineering* 18, no. 2 (March 26, 2019): 1–11, [Link](#).

Beyond its traditional uses, bamboo has significant potential to become a modern engineered material for Bhutan's construction sector. When properly treated and processed into laminated bamboo lumber (LBL) or similar engineered forms, it can achieve strength and stability comparable to softwoods, making engineered bamboo products suitable for multi-storey buildings and urban construction. Laminated bamboo is created by bonding treated strips with resins to create durable, standardised sections that can be used for both structural and interior applications. Only 20-38 of the 1,200 known woody bamboo species are suitable for structural construction worldwide, underscoring the importance of identifying species that are locally appropriate across Bhutan's diverse bio-regions.⁴⁰ Research highlighted that improved data collection, species selection, performance testing, and pilot plantations should form the starting point of a national bamboo strategy.



Fig. 3.9:
Rural housing using raw
bamboo
© Tino Imsirovic, 2024

In addition to the lack of domestic value chains and enabling policies, social perceptions also hinder the advanced application of bamboo in construction. Bamboo is often regarded as a "poor people's material," associated with temporary or low-quality construction. Combined with the absence of data for construction-suitable species in Bhutan, such perceptions have discouraged both professionals and clients from considering bamboo for mainstream use.

41

Salim Barbhuiya et al., "Sustainable Solutions for Low-Cost Building: Material Innovations for Assam-Type House in North-East India," Case Studies in Construction Materials 22 (2025), [Link](#).

42

Dolor R Enarevba and Karl R Haapala, "The Emerging Hemp Industry: A Review of Industrial Hemp Materials and Product Manufacturing," AgriEngineering 6, no. 3 (August 14, 2024): 2891–2925, 2917, [Link](#).

43

Paweł Dudziec, Kazimierz Warmański, and Mariusz Jerzy Stolarski, "Industrial Hemp as a Multi-Purpose Crop: Last Achievements and Research in 2018–2023," Journal of Natural Fibers 21, no. 1 (June 27, 2024), 10, [Link](#).

44

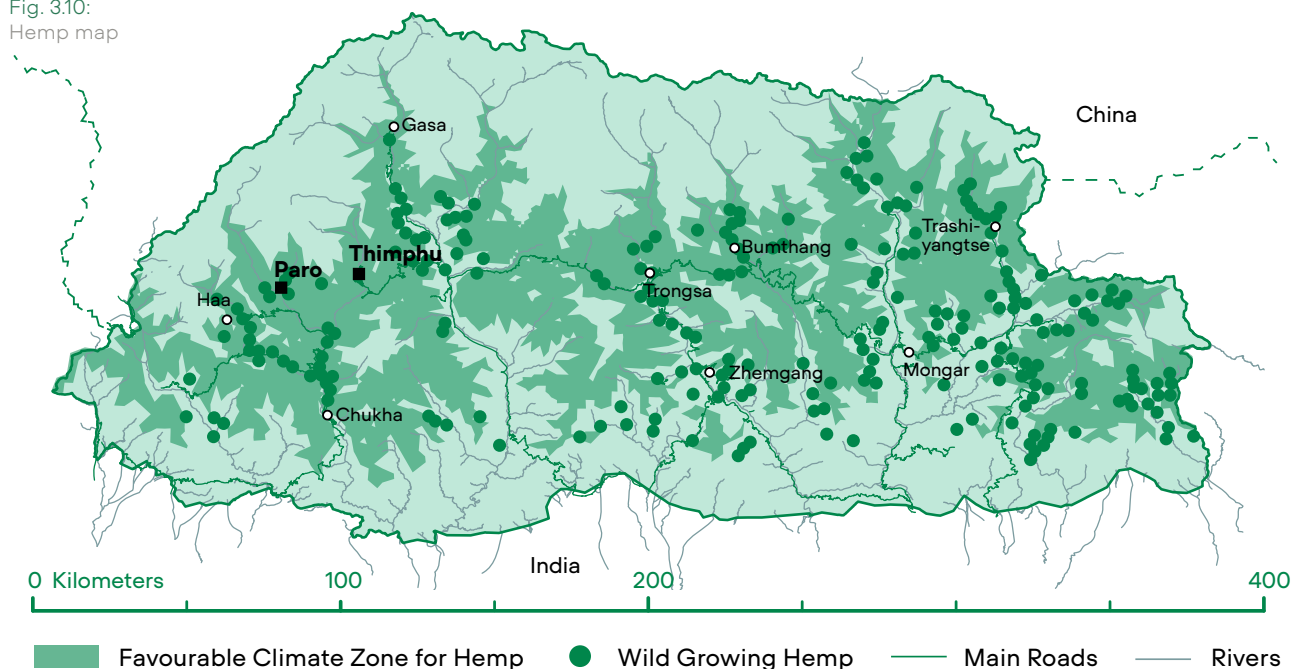
Jay H. Arehart, William S. Nelson, and Wil V. Srubar, "On the Theoretical Carbon Storage and Carbon Sequestration Potential of Hempcrete," Journal of Cleaner Production 266 (September 2020), 2, [Link](#).

However, Bhutan's regional position offers significant potential for collaboration and sector development. Neighbouring India's North-East, particularly Assam, has long-established bamboo industries, creating the possibility of cross-border cooperation on species selection, processing, and product development that could accelerate Bhutan's transition from raw pole imports to the domestic production of treated and engineered bamboo.⁴¹

Hemp Value Chain

Hemp (*Cannabis Sativa L.*) presents an emerging opportunity for Bhutan to build a regenerative, self-sufficient, and low-carbon construction sector. As a fast-growing, multipurpose crop, hemp can simultaneously provide renewable raw materials for bio-based building products, improve agricultural resilience, and strengthen rural livelihoods.⁴² Its carbon-sequestration capacity, short growth cycle, and adaptability to diverse climatic zones make it particularly suitable for Bhutan's agro-ecological regions. Within just five months of growth, hemp can store as much carbon per hectare as a young forest does in a year,⁴³ while its fibrous biomass can be processed into insulation, plasters, and hemp-based composites – potentially carbon-negative building products.⁴⁴ Given Bhutan's reliance on energy-intensive and imported building materials, the development of a hemp-based value chain could help address both the ecological and socio-economic vulnerabilities of the current construction sector.

Fig. 3.10:
Hemp map



45

Hemp consortium, 2023 (unpublished raw data), Thimphu, Bhutan.

46

United Nations Office on Drugs and Crime (UNODC), "South Asia Regional Profile - Bhutan," UNODC.org, 2005, [Link](#).

Hemp already grows wild across the country. An unpublished study estimates roughly 380 hectares of wild hemp, over 80% of which grows on State Reserve Forest Land (SRFL).⁴⁵ Historically, the plant has been used for feeding livestock and making fibre products, yet industrial cultivation remains prohibited by law.⁴⁶ Nevertheless, public and private interest in legalising hemp cultivation has grown considerably in recent years.

Introducing regulated industrial hemp could diversify Bhutan’s agricultural base while enabling a new class of nature-based construction materials that complement the country’s forestry resources.

Fig. 3.11 (left):
Wild growing hemp in
Bumthang
© Kéan Koschany, 2024



Fig. 3.12 (right)
Manual fibre separation of
retted hemp stems
© Matěj Vacek, 2025



ReBuilt’s 2025 cooperation with the Tarayana Foundation demonstrated this potential in practice.⁴⁷ During community workshops, participants produced and tested hemp-lime and hemp-earth bricks using wild-grown hemp and locally available binders. These initiatives revealed strong interest in the material and a shared view that hemp could help address Bhutan’s poor energy performance in modern buildings, which currently suffer from high electricity demand for heating and cooling due to uninsulated walls and inefficient materials.⁴⁸ As residential and commercial buildings account for nearly 15% of Bhutan’s total electricity consumption, with 78% of institutional energy use dedicated to space conditioning, developing local insulation materials such as hemp could substantially reduce operational emissions and dependency on imported energy, while simultaneously improving indoor climates and acoustic insulation.^{49, 50}

⁴⁷ Bauhaus Earth, “Bhutan – Exploring Hemp for Regenerative Construction,” Bauhauserde.org (Bauhaus der Erde gGmbH, May 22, 2025), <https://www.bauhauserde.org/articles/building-with-nature-hemp-in-bhutan>, [Link](#).

⁴⁸ Mark F. Jentsch et al., “Field Study of the Building Physics Properties of Common Building Types in the Inner Himalayan Valleys of Bhutan,” *Energy for Sustainable Development* 38 (June 2017): 48–66, [Link](#).

⁴⁹ Department of Energy, “Bhutan Energy Data Directory 2022,” (Thimphu, Bhutan, 2023), 18, [Link](#).

⁵⁰ Raluca Fernea et al., “Hemp-Clay Building Materials - an Investigation on Acoustic, Thermal and Mechanical Properties,” *Procedia Manufacturing* 32 (2019): 216–23, [Link](#).

⁵¹ Department of Engineering Services, “Bhutan Green Building Design Guidelines” (Thimphu, Bhutan, 2013), 66.

At present, however, no hemp-based construction value chain exists in Bhutan. Cultivation for industrial purposes remains legally restricted, and there are no facilities for fibre processing or binder formulation. As a result, hemp’s potential remains limited to small-scale experimentation. Institutional hesitancy is tied to regulatory complexity and the plant’s association with narcotics. Moreover, no technical standards or testing frameworks exist to evaluate the performance or safety of hemp-based products under Bhutanese conditions. These regulatory and technical gaps mirror those of other emerging bio-based materials and underscore the need for coordination among ministries, research institutions, and the private sector.

Nevertheless, the foundation for a future hemp ecosystem is emerging. The inclusion of hemp in Bhutan’s Green Building Design Guidelines signals institutional awareness, and local interest has increased rapidly through ongoing research and pilot activities by ReBuilt and the Tarayana Foundation.⁵¹

52

Department of Engineering Services, "Bhutan Green Building Design Guidelines" (Thimphu, Bhutan, 2013), 69.

53

Nimesh Chettri, Jigme Thinley, and Ghana S. Koirala, "The Comparative Study on Vernacular Dwellings in Bhutan," United International Journal for Research and Technology 1, no. 4 (2020): 30–35, [Link](#).

Earth Value Chain

Earth has been a fundamental construction material in Bhutan for centuries, deeply rooted in the country's architectural heritage and sustainable building practices. Traditional Bhutanese architecture prominently features rammed earth, adobe, and wattle-and-daub techniques, reflecting long-standing adaptations to the region's climatic conditions and seismic activity.⁵²

Rammed earth, in particular, is widely used in the western parts of Bhutan and is evident in the country's iconic dzongs (fortified monastery) and rural dwellings, where thick earthen walls provide excellent thermal insulation and structural resilience – demonstrated by existing earth-based structures that are up to 300 years old.^{53, 54}



Fig. 3.13:

Ruins of a traditional rural dwelling built out of rammed earth near Thinyelgang, Punakha
© Bas Princen for Bauhaus Earth, 2024

54

Paul Jaquin, "Influence of Arabic and Chinese Rammed Earth Techniques in the Himalayan Region," Sustainability 4, no. 10 (October 15, 2012): 2650–60, [Link](#).

55

Department of Culture and Dzongkha Development, "Manual for Seismic Resilient Construction and Retrofitting of Rammed Earth and Stone Masonry Houses in Bhutan" (Thimphu, Bhutan, March 2023), [Link](#).

56

Tshering Dorji et al., "Land Degradation in Bhutan -an Overview," 2021, [Link](#).

57

National Soil Services Centre (NSSC), "Soil Atlas of Bhutan" (Thimphu, Bhutan, 2024).

Despite its strong cultural roots, earth construction remains largely confined to rural contexts, where about 83% of households live in buildings constructed from rammed earth or random stone masonry.⁵⁵ At the same time, traditional building knowledge is at risk of disappearing as skilled craftspeople age and younger workers seek employment in urban areas.

Locally available soils – typically composed of clay, silt, sand, and gravel – make earth-based construction a low-emission and cost-effective alternative to reinforced concrete or fired bricks. Regulated by relevant authorities, earth materials are sourced in quarries or nearby fields and riverbanks by local communities.

However, because extraction can cause environmental degradation, there is a need for clear material-management and resource-use guidelines.⁵⁶ Although such frameworks have yet to be established, the recently published Soil Atlas of Bhutan provides the country's first comprehensive national dataset on soil types and properties, offering an essential foundation for future research into their suitability for construction.⁵⁷

Although efforts by domestic institutions – such as the Royal University of Bhutan (RUB) and the National Soil Service Centre (NSSC) – as well as collaborations with international universities aim to close knowledge gaps on earth-based construction,⁵⁸ reliable data on the mechanical and thermal performance of Bhutanese soils is still limited. Additionally, existing pilot projects showcasing earth-based construction techniques – while strengthening confidence and building technical capacity – are mostly confined to rural settings and housing typologies, and are rarely transferable to the urban context.



Fig. 3.14-15:
Contemporary earth-based
construction in Bhutan
© Tino Imsirovic, 2024

The lack of technical standards and codes, testing capacities, and certification mechanisms further limits wider application. A manual for seismic-resilient construction and retrofitting provides an important first step towards modernising earth-based building practices.⁵⁹ Yet, expanded research, testing, and codification are required to assess the suitability of earth for urban applications and multi-storey buildings, and to adapt vernacular techniques for contemporary nature-based construction. Strengthening applied research on stabilised and compressed earth could support the inclusion of earthen materials in Bhutan’s building code and public procurement frameworks.

58

Matthijs P. B. van Jaarsveld, “Investigating and Improving Thermal Performance of Bhutanese Rammed Earth Dwellings,” Lub.lu.se (Masters Thesis, 2019), [Link](#).

59

Department of Culture and Dzongkha Development, “Manual for Seismic Resilient Construction and Retrofitting of Rammed Earth and Stone Masonry Houses in Bhutan” (Thimphu, Bhutan, March 2023), [Link](#).



Thematic Vision

Bhutan envisions a construction sector sustained by thriving, resilient value chains of nature-based materials. Timber, bamboo, hemp, and earth are responsibly cultivated, sourced, processed, and applied across scales – from rural housing to urban developments – forming the backbone of a regenerative and low-emission built environment. Regional ecosystems of cultivation, manufacturing, and craftsmanship create dignified livelihoods, strengthen community stewardship of natural resources, and reduce reliance on imported, emission-intensive materials. Bhutan's natural resources not only sustain biodiversity but also actively support a circular, self-reliant, and culturally rooted construction economy.



Fig. 3.16:
Timber depot at a FMU in Bumthang
© Bas Princen for Bauhaus Earth, 2024

Overview of Actions

Regional Opportunity 1 focusses on activating Bhutan’s diverse biomass resources as the material foundation for a regenerative construction sector. Beginning with comprehensive resource assessments and pilot projects, and extending to the establishment of regenerative cultivation and processing systems, RO1 enhances self-sufficiency, reduces import dependency, and creates inclusive economic opportunities across Bhutan’s regions. Interlinked with the other roadmap areas, RO1 provides the material basis for research and innovation (RO2), relies on enabling regulatory frameworks (RO3), requires targeted financing mechanisms (RO4), and supports education and capacity-building initiatives (RO5).

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1. Identify and Close Data Gaps on Biomass Supply for Local Construction

Timestamp

Short Term
(2030)

Scale



Material



Regional

Key Intervention Fields:

- Ecosystem Care
- Material Transition

Stakeholders:

- Natural Resources Development Corporation Ltd.
- College of Natural Resources
- College of Science and Technology
- Jigme Namgyel Engineering College
- Department of Forests and Park Services
- Ugyen Wangchuck Institute for Forestry Research and Training
- Tshar Institute
- National Soil Service Center
- National Land Commission
- Rural Communities
- Community Forest Management Groups
- Non-timber Forest Products Group

Description:

This action calls for a comprehensive national assessment of Bhutan's key biomass resources for construction – timber, bamboo, hemp, and earth. While timber is relatively well documented, the other materials remain largely underexplored, particularly in relation to urban construction demand. Building on and strengthening existing data-collection practices, this short-term action will systematically gather key data to establish a reliable evidence base on the availability, quality, and sustainable yield of these materials, aligned with construction demand, market potential, and future policy needs.

The assessment will also analyse material-specific value chains, covering aspects from raw material availability and geographic distribution to processing, market access, and long-term feasibility. It will include resource mapping and evaluation of soil and climatic suitability, cultivation requirements, and the identification of appropriate species. Environmental impact assessments and reviews of existing and emerging processing technologies will further inform the sustainable scaling of nature-based material production, while identifying barriers, enabling conditions, and opportunities for community-based participation, as well as for establishing networks of growers, processors, and distributors.

Impact

- Establishes a reliable national evidence baseline on the availability, distribution, and sustainable yield of nature-based materials.
- Enables data-driven policy design, planning, and investment decisions across ministries and development partners.
- Strengthens market confidence and investment readiness for nature-based construction materials.
- Lays the groundwork for future resource governance frameworks and certification systems.

Trade-offs

- Potential tension may arise between expanding biomass use for construction and maintaining ecological integrity or competing land uses (e.g., agriculture, conservation.)
- Requires significant funding, inter-agency coordination, and institutional capacity to harmonise data collection and monitoring efforts.

2. Strengthen Sustainable Bio-regional Timber Supply

Timestamp

Short Term
(2030)

Scale



Material



Regional

Description:

Building on the resource assessments conducted under Action 1, this action focuses on improving the management and harvesting of Bhutan's FMUs and community forests to strengthen ecological integrity and increase economic value. The forest policies of the Ministry of Energy and Natural Resources (MoENR) provide a strong foundation for maximising both climate functions of forests and the value of forest products within a development context.

The prioritisation of timber species will be guided primarily by supply considerations for the construction sector, ensuring that forest management aligns with national material demand. Identified priority species and suitable forest regions will inform climate-appropriate reforestation and afforestation efforts, developed in collaboration with community forestry management groups, regional forest divisions, and non-timber forest product groups. These efforts will support watersheds, biodiversity, soil health, and broader ecological systems while sustaining livelihoods and enhancing forest resilience to climate change.

To strengthen harvesting capacity, cable-logging systems will be expanded in areas without road access, while mobile sawmills will enable processing close to remote harvest sites, reducing transport emissions and material waste. Sustainable forest protocols for harvesting on Bhutan's steep slopes – such as line felling and associated group harvesting – should be implemented in ways that protect slopes and minimise the footprint of felling operations. All harvesting systems will adhere to certification standards that ensure social, economic, and environmental safeguards.

GIS-based mapping will help identify degraded or underutilised forest areas suitable for afforestation, supported by technical guidelines and manuals for regenerative forest management. In the longer term, afforestation strategies will be informed both by ecological concerns and by projected construction demand, taking into account which species will maintain environmental resilience and which will be needed in 40-60 years from now to secure a sustainable national timber supply.

Impact

- Aligns forest management with long-term construction demand, linking ecological stewardship to material security.
- Strengthens forest governance and local management capacities through collaboration between public agencies and community forestry groups.
- Enhances the sustainability and traceability of timber harvesting through certification and spatial monitoring systems.
- Contributes to climate adaptation by improving forest resilience and supporting species diversification.
- Generates employment and knowledge transfer in sustainable forestry and regenerative forest management practices.

Trade-offs

- High upfront investment and training requirements for modern harvesting technologies such as cable systems and mobile sawmills.
- Potential short-term productivity declines during the transition to new harvesting methods and certification requirements.
- Requires continuous coordination among forestry agencies, local communities, and private operators to align regenerativity goals with market objectives.
- Risk of overharvesting or ecological disturbance if value-chain optimisation is not accompanied by strong safeguards and robust monitoring systems.

3. Strengthen Sustainable Bio-regional Timber Supply

Timestamp



Short Term
(2030)

Scale



Material



Regional

Description:

This action focuses on modernising Bhutan's timber processing and distribution systems to improve efficiency, product quality, and value creation while upholding environmental and occupational health and safety (OHS) safeguards. Processing and distribution systems will be developed in alignment with certification standards to ensure social, economic, and ecological responsibility. Strengthened traceability mechanisms – including digital tagging and geospatial monitoring – will enable transparent tracking of timber flows in compliance with certification schemes. Upgrading road and forest transport networks will improve connectivity and extraction efficiency, while targeted investment in sawmills, kilns, and manufacturing facilities will expand national processing capacity and stimulate local enterprise development.

To enhance material efficiency, this action will prioritise technologies and practices that maximise the use of harvested wood and minimise losses during milling, drying, and storage. Secondary wood flows and by-products – such as sawdust, chips, and offcuts – will be repurposed into new value-added products. In the medium term, clusters with shared infrastructure – including drying, storage, and packaging facilities – will be developed in alignment with Bhutan's decentralised forestry industry. These efforts will promote circular resource flows, reduce embodied emissions, and strengthen the economic viability of locally sourced timber within Bhutan's regenerative construction sector.

Key Intervention Fields:

- Ecosystem Care
- Material Transition

Stakeholders:

- Natural Resources Development Corporation Ltd.
- College of Natural Resources
- Department of Forests and Park Services
- Ugyen Wangchuck Institute for Forestry Research and Training
- Department of Trade
- Department of Industry
- Rural Communities
- Community Forest Management Groups
- Non-timber Forest Products Group

Impact

- Strengthens domestic value creation by improving processing efficiency and product quality.
- Reduces material waste and embodied emissions through circular resource flows and the reuse of by-products.
- Stimulates local entrepreneurship and supports rural empowerment in timber-producing regions.
- Fosters innovation, skill development, and employment opportunities in modern timber-processing technologies and logistics management.

Trade-offs

- Significant capital investment is required to upgrade facilities, transport networks, and digital monitoring systems.
- Short-term disruptions may occur in existing supply chains during infrastructure modernisation.
- Ongoing maintenance and technical capacity will be needed to ensure long-term efficiency and quality control.
- Certification and compliance processes may increase administrative workload, particularly for small-scale producers.

4. Identify Construction-Suitable Bamboo Species for Cultivation and Establish Processing Centers

Timestamp

Medium Term
(2040)

Scale



Material



Regional

Description:

This action targets the identification and testing of bamboo species suitable for Bhutan's diverse bio-regions, alongside the development of sustainable cultivation and processing systems for construction applications. Coordinated research will assess species performance under local climatic and topographical conditions and evaluate mechanical properties relevant to building products. To ensure long-term adaptability, monitoring mechanisms will be established to continually reassess the suitability of bamboo species in response to changing environmental and market conditions, with findings regularly shared with growers and processors.

Following species selection, pilot plantations will be established to generate data on environmental impacts, input requirements, expected yields, and harvesting methods. In parallel – during the 3-5-year maturation cycle – strategically located treatment and processing centres will be developed to enable preservation, grading, and value addition aligned with construction standards. Bamboo farmers and community growers will receive training and capacity-building support to participate in ongoing species monitoring and to align cultivation practices with technical and environmental requirements.

Key Intervention Fields:

- Ecosystem Care
- Material Transition
- Capacity Strengthening

Stakeholders:

- Natural Resources Development Corporation Ltd.
- College of Natural Resources
- College of Science and Technology
- Department of Forests and Park Services
- Department of Human Settlement
- Tshar Institute
- International Bamboo and Rattan Organisation
- Private Companies
- Community Forest Management Groups
- Non-timber Forest Products Group

Impact

- Establishes a reliable domestic supply of construction-suitable bamboo, reducing import dependency.
- Creates an evidence base for standards development and certification, accelerating market acceptance and procurement eligibility.
- Expands the portfolio of nature-based building materials, eases pressure on timber supply.
- Strengthens rural livelihoods and local value addition through cultivation, processing, product manufacturing, and other business opportunities along the value chain.

Trade-offs

- High upfront investments and a 3-5 year waiting period for material availability due to the maturation cycle.
- Ecological risks if species selection or plantation design leads to monocultures, invasive spread, or habitat pressure without adequate safeguards.
- Land-use competition and community concerns if cultivation expands without clear zoning and benefit-sharing arrangements.
- Market and performance uncertainty until standards, design guidelines, and enabling policies are established.

5. Establish Pilot Areas for Industrial Hemp Production

Timestamp



Short Term
(2030)

Scale



Material



Regional

Description:

This action focuses on establishing pilot hemp cultivation sites across Bhutan's suitable agro-ecological zones to assess the plant's potential as a regenerative building material. Pilot areas will be developed on various land types – private farmland, community forests, state reserve land, and leased entrepreneurial plots – in collaboration with local authorities, research institutions, and community groups. These sites will enable systematic testing under different cultivation conditions, including variations in soil type, altitude, and monsoon exposure, to identify optimal growing environments and species suited to Bhutan's climatic conditions.

The pilot programme will generate key data on suitable plant varieties, expected yields, fertiliser and input requirements, and the environmental impacts of cultivation under different management practices. It will also examine how hemp can be integrated into existing farming systems and crop rotation schemes, supporting local livelihoods while maintaining soil fertility and biodiversity. Data and insights gathered over several growing seasons will provide a solid evidence base for feasibility assessments and decision-making on the economic, environmental, and technical potential of hemp cultivation in Bhutan. Close collaboration among farmers, local authorities, academia, and national agencies will ensure that the findings inform future policy frameworks, investment strategies, and opportunities to scale hemp-based building materials.

Key Intervention Fields:

- Ecosystem Care
- Material Transition

Stakeholders:

- Natural Resources Development Corporation Ltd.
- Druk Holding and Investments Ltd.
- Department of Forests and Park Services
- Department of Industry
- Department of Employment and Entrepreneurship
- Department of Agriculture
- Biosafety and Food Regulation Authority
- Bhutan Narcotics Control Authority
- College of Science and Technology
- College of Natural Resources
- Local Communities and Farmers

Impact

- Positions Bhutan as an early mover in developing regionally adapted hemp-based construction solutions aligned with its carbon-neutral development goals.
- Provides policymakers and investors with robust data on the technical and economic feasibility of hemp-based material production.
- Enhances local livelihoods by diversifying income streams and introducing new value chains for regenerative materials.
- Strengthens institutional collaboration between research institutes, local governments, and farming communities, creating pathways for applied innovation.

Trade-offs

- High initial investment and technical uncertainty during early cultivation cycles before reliable data are established.
- Requires effective inter-agency coordination for regulatory approvals, data collection, and market development.
- Possible land-use conflicts with food production if not carefully planned and implemented.
- Risk of environmental degradation if fertiliser use, water demand, or soil impacts are not properly managed during pilot or scaled cultivation.

6. Assess and Advance Earth-Based Construction

Timestamp

Medium Term
(2040)

Scale



Material



Regional

Key Intervention Fields:

- Ecosystem Care

- Material Transition

Stakeholders:

- Natural Resources Development Corporation Ltd.

- National Land Commission

- National Soil Service Center

- Druk Holding and Investments Ltd.

- Department of Forests and Park Services

- Department of Geology and Mines

- Department of Human Settlement

- Department of Labour

- College of Science and Technology

- College of Natural Resources

- Local Artisans and Builders

Description:

This action focuses on assessing the technical and environmental feasibility of earth-based construction in Bhutan's urban areas. Using existing soil data and geospatial mapping, high-potential zones for material sourcing will be identified and analysed in terms of quality, extraction potential, and environmental sensitivity. Priority will be given to utilising local resources, excavation waste from construction sites, and other secondary soil flows before considering new extraction areas. The assessments will evaluate ecological limits, rehabilitation needs, and long-term sustainability to ensure that any scaling of earth-based materials does not compromise ecosystems or local landscapes.

In parallel, applied research and pilot testing – conducted with academic institutions, local communities, non-profit organisations, artisans, and builders – will adapt traditional earthen construction knowledge to modern applications such as compressed earth blocks, stabilised adobe, and contemporary rammed earth systems. These activities will generate performance data on strength, durability, moisture resistance, and thermal behaviour, supporting the development of updated technical standards and future revisions to the Bhutan Building Code. The findings will provide a robust evidence base for determining where and how earth-based construction can contribute meaningfully to Bhutan's regenerative building agenda, while safeguarding ecological integrity and preserving vernacular construction knowledge.

Impact

- Builds a comprehensive evidence base on the technical and environmental feasibility of earth-based materials in Bhutan's construction sector.
- Revives and modernises traditional earthen building knowledge, linking cultural heritage with contemporary regenerative design.
- Supports low-carbon, locally sourced construction options that can complement other bio-based materials in suitable contexts.
- Reduces the import of emission intensive clay bricks for construction.

Trade-offs

- Ecological risks from over-extraction or poorly managed sourcing if safeguards are not strictly enforced.
- Limited scalability in dense urban areas due to material availability, land constraints, or environmental sensitivities.
- Higher initial costs for material testing, certification, and quality control compared to conventional materials.
- High transport-related costs and emissions if earth is not sourced locally.

Regional Opportunity 2



Fig. 3.17:
Temple Reconstruction, Lamai Lhakhang, Paro
© Bas Princen for Bauhaus Earth, 2024

Utilising global and regional research and innovation to strengthen domestic research capacities for Bhutan's regenerative construction sector

Background and Problem Statement

Bhutan's construction sector stands at a pivotal moment of transformation, shaped by accelerating urbanisation, unsustainable building practices, and national ambitions for carbon-neutral development. As the built environment becomes a key driver of economic growth, the need for innovation in regenerative and nature-based solutions is higher than ever. New technologies for sustainable building materials represent an emerging market, and Bhutan's rich natural resources position the country to participate in it.

Yet, research and innovation capacities within Bhutan's construction ecosystem remain at an early stage. Existing efforts across government agencies, universities, and research institutes are increasing but often fragmented, limiting the country's ability to generate the technical, social, and environmental knowledge required to guide a transition towards regenerative building practices.

This gap is most apparent in the field of nature-based construction materials, which – despite their availability, cultural relevance, and potential for regenerative construction – remain insufficiently studied and tested within the Bhutanese context. This is especially true for bamboo, hemp, and earth, while supply-specific data for timber exists and continues to grow.

Nevertheless, reliable data on the materials' mechanical, thermal, and environmental performance – as well as their life-cycle impacts, resilience to natural hazards, and circular reuse potential – are largely absent. Without such evidence, it is difficult to establish technical standards, certification systems, or economic models that would support their safe and scalable application. The resulting dependence on foreign testing facilities and external expertise slows progress, increases costs, and reduces the contextual relevance of research outcomes.

Beyond research gaps, Bhutan's innovation ecosystem lacks the structures needed to translate scientific knowledge into market-ready solutions. Beyond exchanges that include professional associations or national council working groups, few formal mechanisms link academia, government, and the private sector, resulting in limited collaboration between researchers, entrepreneurs, and practitioners. As a result, promising ideas often remain confined to standalone pilot projects or academic studies, without pathways for incubation, financing, or scaling. This constrains the emergence of a domestic regenerative construction industry capable of competing with conventional, import-based supply chains.

The absence of circularity-oriented research further limits the potential for market and material innovation. Waste from demolition and construction is rarely recovered or reused, and no dedicated initiatives currently assess the



Fig. 3.18:
View from Bumthang-Ura
highway
© Kéan Koschany, 2024

environmental and economic benefits of circular material flows within the construction sector. Without systematic research and pilot projects on reuse, upcycling, retrofitting, and material recovery, Bhutan risks missing a critical opportunity to embed resource efficiency and waste reduction into its construction industry.

These systemic gaps weaken the foundations for Bhutan's regenerative transition. The lack of research infrastructure, data, and innovation linkages limits progress in market innovation, deters investment, and slows skill development. Building an integrated research and innovation ecosystem – combining data generation, testing facilities, and entrepreneurial experimentation – will be essential to unlock Bhutan's potential for context-specific regenerative construction solutions.

Project Findings

Research and Testing Infrastructure for Nature-Based Construction

Stakeholder consultations and survey data consistently identified the lack of domestic research and testing infrastructure as one of the most pressing barriers to advancing regenerative construction in Bhutan. While institutions such as the RUB and its CST have begun to explore material research, there is still no central facility capable of systematically assessing the physical, mechanical, and environmental performance of timber, bamboo, hemp, or earth. This gap prevents the generation of reliable data needed to inform building codes, structural designs, certification systems, and investment decisions to match product quality and safety standards.

As a result, Bhutan remains dependent on foreign laboratories and external expertise. ReBuilt’s 2024 perception study confirms that the absence of verified performance data is among the most frequently cited reasons why practitioners hesitate to adopt nature-based materials, underscoring the urgency of building national testing capacity.⁶⁰



Fig. 3.19:
Timber logs at a FMU in
Bumthang
© Kéan Koschany

The recently announced memorandum of understanding (MoU) between DHI and CST to establish the country’s first Structural Timber Testing, Research, and Promotion Facility marks a critical step toward closing this gap.⁶¹ The initiative aligns with the 13th Five-Year Plan’s emphasis on applied research and innovation and demonstrates growing institutional commitment to building technical capacity. Similar partnerships under the ReBuilt project – including material testing with the AIT and prototyping workshops with the Tarayana Foundation – have highlighted the potential of cross-institutional collaboration.

However, stakeholders stressed that lasting progress will depend on sustained investment, long-term coordination between the Ministry of Infrastructure and Transport (MoIT), RUB, and DHI, and the integration of socio-ecological research dimensions into the testing agenda to ensure that innovation remains grounded in Bhutan’s environmental and cultural context.

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Arushi Gupta, Jamyang Penjore, and Georg Hubmann, “Perceptions of Nature-Based Materials in Bhutan’s Construction Sector,” (unpublished conference paper) (Sustainable Built Environment Conference, 2025).

61

Druk Holding & Investments Ltd., “DHI and CST Partner to Establish Bhutan’s First Structural Timber Testing and Research Facility,” [Www.dhi.bt](#), February 11, 2025, [Link](#).

Entrepreneurship and Innovation for Regenerative Building Practices

Workshops and survey results revealed that Bhutan's innovation ecosystem for construction remains fragmented and underfunded, with limited institutional support to translate research into market-ready products. Early initiatives – such as DHI's Business Acceleration Programme (BizAp), the United Nations Development Programme (UNDP) Bhutan Accelerator Lab, and the Super FabLab in Thimphu – have laid an initial foundation for innovation and prototyping, yet none focus explicitly on regenerative construction. Participants therefore called for a dedicated accelerator platform to support innovators, start-ups, and small enterprises in developing, testing, and commercialising nature-based construction products and services.

The 2024 perception survey further highlights the scale of this innovation gap: most professionals reported limited familiarity or practical experience with nature-based materials, and only a small fraction had worked on projects involving regenerative design. These findings underline the need for structured innovation pathways that connect applied research, training, and entrepreneurship. A dedicated accelerator could address this gap by providing seed financing, mentorship, and access to testing facilities, while linking entrepreneurs with universities, research institutions, and private investors.

Fig. 3.20:
Rural building utilising
rammed earth, bamboo, and
hempcrete in Gomche, Paro
© Matěj Vacek, 2025

Fig. 3.21 (right):
Hemp-earth wall with woven
bamboo reinforcement at
TSHAR institute, Mongar
© Matěj Vacek, 2025



Existing pilot projects – such as bamboo-hempcrete housing by the Tarayana Foundation in rural Bhutan, and the emerging glulam and mass-timber facilities by DHI and the Natural Resources Development Corporation Limited (NRDCL) – demonstrate growing momentum but remain largely isolated examples.⁶² The planned mass-engineered timber factory for GMC represents a particularly significant opportunity to anchor research and innovation capacities within a major development context.⁶³

At the same time, stakeholders emphasised that large-scale industrial facilities must be complemented by decentralised, small-scale approaches that reflect Bhutan's diverse settlement patterns, resource variability, and local livelihood needs. Strengthening community-based enterprises, micro-industries, and craft-oriented production is therefore essential to ensure that innovation remains inclusive and regionally embedded. A coordinated acceleration programme that supports both industrial and decentralised approaches could catalyse these efforts, helping Bhutan develop a self-sustaining regenerative construction economy that generates employment, reduces import dependence, and strengthens domestic value chains.

⁶² Tarayana Foundation, "Promoting Disaster Resilient Rural Housing with Hempcrete & Bamboo" Tarayanafoundation.org, 2025, [Link](#).

⁶³ "GMC to Establish Nu 1 Bn Mass Engineered Timber Factory," The Bhutanese, April 19, 2025, [Link](#).



Fig. 3.22:
Discarded timber elements
© Bas Princen for Bauhaus
Earth, 2024

Advancing Circular Material Flows in Construction

Across the research process, circularity emerged as a unifying theme and a necessary extension of regenerative principles within Bhutan's construction sector. Stakeholders consistently highlighted the opportunity to reuse, recycle, and refurbish building materials to extend material lifecycles and significantly reduce waste. Priority measures include mapping demolition waste streams, creating material inventories and reuse standards, and integrating design-for-disassembly principles into building practice. Beyond lowering the environmental footprint of new construction, circular strategies also offer pathways to preserve cultural heritage through the adaptive reuse and revitalisation of existing structures.

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Arushi Gupta, Jamyang Penjore, and Georg Hubmann, "Perceptions of Nature-Based Materials in Bhutan's Construction Sector," (unpublished conference paper) (Sustainable Built Environment Conference, 2025).

65
Mohamed Al et al., "Investigation of Construction Waste Material Using Multi Criteria Decision Making Method: A Case Study in Bhutan," Deleted Journal 7, no. 1 (January 9, 2025), [Link](#).

66
Rigden Yoezer Tenzin et al., "Assessment of Timber Engineering Needs and Practices in Bhutan: A Comprehensive Study," International Wood Products Journal 15, no. 2-4 (August 19, 2024), [Link](#).

The study by Gupta et. al (2025) indicates that although professionals widely recognise the environmental benefits of circular construction, many remain uncertain about its technical feasibility and cost implications in the Bhutanese context.⁶⁴ Workshop participants similarly emphasised that advancing circularity will require technical research and regulatory adaptation in tandem with improved education and awareness. Integrating circular principles into technical and vocational education and training (TVET) programmes and university curricula, – supported by applied research and pilot projects – could help mainstream reuse and refurbishment practices across the sector.

Early-stage initiatives led by the CST and other academic partners signal growing research interest in construction waste and regenerative building practices.^{65, 66} However, the lack of coordinated policy guidance, reliable data, and technical standards continues to constrain meaningful implementation.

Addressing these gaps through targeted R&I, regulatory reform, and demonstration projects would establish the foundation for a circular construction economy that is grounded in Bhutan's local resource base and aligned with its environmental commitments.

Thematic Vision

Bhutan envisions a research and innovation landscape in which science, craftsmanship, and entrepreneurship work together to drive regenerative construction. Domestic research centres, testing facilities, and creative enterprises form an interconnected ecosystem that continuously generates, validates, and applies knowledge on nature-based materials. Robust evidence informs decision-making across policy, design, and industry, while circular practices ensure that resources are used responsibly and regenerated over time. Innovation is firmly rooted in Bhutan's ecological realities and local capabilities – empowering a self-reliant construction sector that strengthens human potential while safeguarding the natural systems on which it depends.



Fig. 3.23.
Ugyen Wangchuck Institute for Forestry Research and Training
© Bas Princen for Bauhaus Earth, 2024

Overview of Actions

Regional Opportunity 2 focuses on strengthening Bhutan’s research and innovation ecosystem as a cornerstone of the national transition towards regenerative construction. By investing in research and testing infrastructure, establishing dedicated innovation and entrepreneurial accelerators, and advancing circular material flows, RO 2 connects scientific inquiry with applied practice – bridging academia, government, and industry in generating regenerative solutions tailored to Bhutan’s context. Functioning as the connective tissue of the entire roadmap, RO2 enables the development of nature-based value chains (RO1), supports regulatory reforms through data-driven standards and certification systems (RO3), underpins financial instruments and investor confidence (RO4), and informs the design of education and capacity-building programmes (RO5).

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1. Invest in Research and Testing Facilities for Nature-Based Construction Practices

Timestamp

Short Term
(2030)

Scale



Material



Building

Description:

Targeted investment in research and testing infrastructure is essential to provide the scientific and technical foundation for Bhutan's transition towards a regenerative construction sector. Establishing and expanding dedicated facilities within existing universities, research institutes, and technical centres will enable systematic testing of the physical, structural, thermal, and environmental performance of locally available materials such as timber, bamboo, hemp, and earth. Equipped with up-to-date technologies, these facilities will also support entrepreneurs in developing and validating nature-based building products, while generating the evidence needed for national certification frameworks that reflect Bhutan's environmental, climatic, and cultural conditions. In doing so, Bhutan will strengthen its domestic knowledge base and enhance confidence among policymakers, practitioners, and investors – laying the groundwork for a safe, scalable, and context-appropriate uptake of regenerative construction materials.

Beyond technical performance, research will also examine the socio-ecological implications of nature-based construction. Partnerships between government, academic institutions, and research organisations will be essential to assess the sustainability of sourcing practices – ensuring that material extraction and cultivation maintain ecological balance, protect critical ecosystem services, and support rural economies and livelihoods. By embedding these social and environmental dimensions into the national research and innovation agenda, Bhutan can create the foundations of evidence-based regulation, certification, and investment. In doing so, the country positions its construction sector as a model for carbon-neutral development that is socially inclusive, environmentally responsible, and culturally grounded.

Key Intervention Fields:

- Material Transition
- Capacity Strengthening

Stakeholders:

- Multistakeholder Investment Roundtable and Advisory Committee (RO4, Action 1)
- Department of Human Settlement
- Department of Forests and Park Services
- Druk Holding and Investments Ltd.
- College of Natural Resources
- College of Science and Technology
- Bhutan Development Bank
- Domestic Banks and Funds
- National Environment Commission
- Existing Research Centres
- Regional Research Networks

Impact

- Strengthens the infrastructural and technical foundation for evidence-based decision-making across the construction sector.
- Builds domestic research and testing capacity, generating context-specific data on regenerative construction.
- Supports the development of certification and quality-assurance frameworks, increasing material credibility and enabling wider market uptake.
- Enhances collaboration between government, academia, and private sector actors, while fostering knowledge exchange with regional and international research networks.
- Reduces long-term dependence on imported expertise, materials, and standards by establishing a resilient domestic knowledge base.
- Boosts investor and policymaker confidence in regenerative construction solutions through verified performance data and transparent testing protocols.

Trade-offs

- Requires substantial upfront investment in laboratory facilities, specialised equipment, and staff training, with limited immediate financial returns.
- May initially depend on foreign expertise and technical partnerships until domestic skills, standards, and institutional capacities are fully developed.
- Involves ongoing operational and maintenance costs that demand sustained financial commitment and long-term budgeting.
- Risk of underutilisation if research agendas are not well-coordinated across ministries, universities, and industry stakeholders.
- Potential inequalities in access if testing services become centralised without complementary regional outreach or decentralised support mechanisms.

2. Launch an Entrepreneurial Accelerator for Innovation in Nature-Based Construction

Timestamp

Medium Term
(2040)

Scale



Material



Building

Description:

To strengthen innovation capacity and expand economic opportunities in the regenerative construction sector, a dedicated accelerator program will be established to support entrepreneurial initiatives focused on nature-based building solutions. The accelerator will provide a platform for emerging businesses, innovators, social enterprises, and practitioners to develop regenerative construction products, services, building systems, and technologies tailored to Bhutan's unique socio-ecological context.

Through collaborations with existing accelerators – such as the DHI Business Acceleration Program (BizAp) or the UNDP Bhutan Accelerator Lab – and by offering access to scientific infrastructure, technical expertise, regional and international knowledge networks, and finance, the accelerator will bridge the gap between research, prototyping, and market application while strengthening the domestic private sector's role in regenerative construction.

Participants will benefit from seed grants and financing, mentorship from local and international experts, and support in developing viable business models for regenerative construction. The program will also facilitate product testing and certification through partnerships with domestic and international research institutions. By combining applied research, market assessments, and entrepreneurial experimentation, the accelerator will help identify viable pathways for regional production networks, circular business models, and green employment generation within the regenerative construction sector. In doing so, it will foster scalable solutions that align with Bhutan's environmental goals while enhancing building performance and material resilience.

Key Intervention Fields:

● Material Transition

● Capacity Strengthening

● Economic Innovation

Stakeholders:

● Department of Human Settlement

● Department of Employment and Entrepreneurship

● Department of Macro Fiscal and Development Finance

● Department of Industry

● Department of Trade

● Druk Holding and Investment Ltd.

● National Environment Commission

● Domestic Banks and Funds

● Super Fab Lab Bhutan

● Existing Research Centres

● Royal University of Bhutan

● Centre for Bhutan Studies and GNH Research

Impact

- Stimulates local innovation and entrepreneurship by creating structured pathways for start-ups and enterprises in regenerative construction.
- Bridges the gap between research and application, accelerating the translation of scientific knowledge into market-ready solutions, services, and building systems.
- Contributes to long-term self-reliance by embedding technical, managerial, and innovation capacities within Bhutan's own institutions, industries, and communities.
- Expands economic opportunities by nurturing business models that strengthen nature-based value chains and generate green employment.

Trade-offs

- Requires significant upfront investment and continued operational support, necessitating sustained public or development-partner funding during early phases.
- Innovation pathways may at times conflict with cultural traditions or established community practices, requiring careful engagement and alignment to ensure social acceptance.
- Adoption and scaling of new products depend on the timely establishment of enabling regulatory frameworks and certification systems, which may delay market uptake.

3. Advance Circular Material Flows in Construction

Timestamp



Long Term
(2050)

Scale



Material



Building

Description:

This action focuses on developing strategies, methods, and technical guidelines for the reuse and recycling of locally available nature-based materials such as timber, bamboo, earth, and hemp. An inventory of commonly used conventional materials (e.g., CGI sheets, fired bricks) will also be established. Particular attention will be given to assessing the performance and durability of reclaimed materials to ensure that safety and quality standards are defined and upheld.

Building professional awareness and integrating circular design principles into education and training programmes will be essential to support practical adoption. Collaborative research and development efforts involving the MoIT, MoENR, RUB, industry stakeholders, and civil society will provide a robust scientific foundation for integrating circular building approaches into policy frameworks and practice.

Beyond new construction, this action also aims to embed circular and regenerative principles into the renovation and refurbishment of existing buildings, preserving cultural value, reducing demolition waste, and lowering the demand for new raw materials. The approach will combine established practices with emerging technologies tailored to Bhutan's environmental, cultural, and material context, ensuring that circularity strategies remain relevant, feasible, and locally grounded. This includes the adapting "urban mining" approaches – such as material recovery, building component reuse, and design-for-disassembly – to Bhutan's construction practices, climate zones, and socio-economic conditions.

Key Intervention Fields:

- Material Transition
- Ecosystem Care
- Economic Innovation
- Building Practices and Culture

Stakeholders:

- Department of Human Settlement
- Department of Environment and Climate Change
- Department of Forests and Park Services
- Department of Industry
- Construction Association of Bhutan
- Wood Based Industries
- Industry Actors
- Demolition and Waste-handling Firms

Impact

- Reduces reliance on extractive and linear construction practices by extending material lifecycles and lowering demand for new raw materials.
- Creates technical expertise, employment opportunities, and business models in areas such as material sourcing, retrofitting, repair services, and secondary markets.
- Improves the environmental performance of the construction sector by lowering embodied emissions and overall resource consumption.
- Enhances resilience of local economies by keeping value within domestic material cycles.
- Strengthens cultural preservation by prioritising renovation and adaptive reuse of existing buildings.

Trade-offs

- Requires substantial upfront investment in infrastructure, skills training, and regulatory reform.
- Demands cross-sectoral coordination, requiring alignment across waste management, construction, and heritage conservation agendas.
- Short-term costs of refurbishment or circular practices may exceed those of conventional construction, creating adoption barriers in the absence of dedicated incentives.
- May face stakeholder resistance due to unfamiliarity with reuse and recycling practices, as well as perceived risks or higher costs.

Regional Opportunity 3

Fig. 3.24:
Temple Reconstruction, Lamai Lhakhang, Paro
© Bas Princen for Bauhaus Earth, 2024



Advance regulatory reforms and policy initiatives to create enabling regulatory frameworks that support the uptake of regenerative planning and building practices

Background and Problem Statement

Enabling regulatory frameworks are a key driver of long-term industrial and societal shifts needed for a transition towards a regenerative construction sector. Bhutan's 13th Five-Year Plan (2024-2029), the main framework guiding the country's ongoing development, reinforces the commitment to environmental conservation, social well-being, economic growth, and responsible development practices. While it does not explicitly reference regenerative construction, its overarching themes of sustainability, ecological integrity, and inclusive development create favourable conditions for integrating regenerative principles into Bhutan's built environment.

At the core of Bhutan's construction regulation lies the Bhutan Building Regulation (2023) and Building Code of Bhutan (2018), which together provide the regulatory and technical foundation for planning and building design.^{67,68} The Building Code of Bhutan is largely based on the Indian Building Code, and its scope remains centred on conventional materials such as concrete and steel. While it includes structural guidance for earthquake-resistant construction, it does not yet provide technical standards for nature-based materials such as timber, bamboo, hemp, or earth.

This absence limits the transition from small-scale pilots to mainstream urban construction, as architects, engineers, and builders lack the legal clarity on how to design, certify, or insure projects using these materials. The ongoing code revision process under the MoIT presents a unique opportunity to close these regulatory gaps and integrate regenerative construction practices, supporting both the adoption of nature-based building materials and innovation around regenerative construction products and processes.

While Bhutan's governance system is well-structured and guided by clear national priorities, the absence of regenerative design principles across sectoral development strategies limits the country's ability to use regulation as a driver of transformation. Current policy frameworks in housing, urban planning, tourism, and resource management each pursue sustainability objectives, yet without cross-sectoral alignment. This fragmentation results in missed opportunities to coordinate regulatory efforts, investment priorities, and implementation mechanisms around a shared regenerative vision. In parallel, existing OHS protocols appear to lack consistent implementation and enforcement, requiring both revision and adaptation to address the specific risks associated with nature-based materials.⁶⁹

Finally, Bhutan currently lacks a comprehensive framework for certification, monitoring, and evaluation of regenerative construction materials and practices. Without such systems, builders, investors, and regulators cannot rely on consistent quality assurance or verifiable data on material

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Ministry of Infrastructure and Transport (MoIT), "Bhutan Building Regulation" (Thimphu, Bhutan, October 2023), [Link](#).

68

Department of Human Settlement, "Building Code of Bhutan" (Thimphu, Bhutan, 2018), [Link](#).

69

Phuntsho Dendup, "A Decade of Occupational Health and Safety in Bhutan," GNH Journal of Construction Technology & Management 2 (January 1, 2021): 23–27, [Link](#).



Fig. 3.25:
Urban space in Thimphu
© Kéan Koschany, 2024

performance. This absence reinforces uncertainty among stakeholders, limits investor confidence, and slows the adoption of regenerative construction in both public and private projects.

In summary, Bhutan's regulatory environment for regenerative construction remains in an early stage of development. Addressing these gaps through coherent legal and institutional reform will be essential to move from demonstration projects to country-wide implementation.

Project Findings

Regulatory Reforms as a Core Enabler

Stakeholder consultations and survey evidence consistently identified policy reform as the most decisive factor for advancing Bhutan's transition towards regenerative construction. Gupta, Penjore & Hubmann, drawing on the 2024 ReBuilt online survey, emphasise that the absence of supportive regulation was perceived as the greatest barrier to using nature-based materials.⁷⁰ This indicates that Bhutan's environmental ambitions will remain aspirational unless they are embedded in clear codes, standards, and certification systems.

At the same time, most respondents expressed strong support for reforms that link environmental goals with practical implementation mechanisms. The 13th FYP (2024–2029) provides a favourable policy framework, but these ambitions have yet to be operationalised within the construction sector, as regenerative and sustainable building principles are not yet explicitly referenced. The consensus emerging from research and dialogue is clear: the transition will depend on translating high-level commitments into enabling, enforceable, coherent, and technically informed regulations.



Fig. 3.26:
Construction site of
contemporary urban
residential building in
Thimphu
© Kéan Koschany

Building Code Revision and Technical Standards

The Building Code of Bhutan forms the technical foundation of the national construction framework but remains largely oriented towards conventional materials such as concrete and steel. The ongoing code revision under the MoIT offers a critical window of opportunity to embed regenerative building principles into Bhutan's regulatory architecture for the construction sector. Professionals frequently cited the lack of standards and clarity on liability as major barriers, reinforcing the need for codified safety and quality parameters.

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Arushi Gupta, Jamyang Penjore, and Georg Hubmann, "Perceptions of Nature-Based Materials in Bhutan's Construction Sector," (unpublished conference paper) (Sustainable Built Environment Conference, 2025).

Stakeholders emphasised that technical guidelines must be informed by empirical data from testing facilities and demonstration projects, establishing a continuous feedback loop between research and regulation. This is especially relevant for timber, bamboo, hemp, and earth – covering structural performance, fire-safety, and energy-efficiency benchmarks – to enable nature-based construction to move from isolated pilot projects to mainstream adoption.



Fig. 3.27:
Employees of the MoIT at a
ReBuilt stakeholder workshop
in Thimphu
© Kéan Koschany, 2024

Policy Alignment and Cross-Sectoral Coordination

Although Bhutan's policy landscape is well structured, fragmentation across ministries and sectors limits the potential of regulation to drive transformation in the construction sector. Findings from stakeholder consultations revealed that regenerative design principles are not yet systematically integrated into housing, urban planning, tourism, or resource-management policies.

It was further noted that frameworks such as the 13th FYP,⁷¹ the Human Settlement Policy (2019),⁷² and the TSP (2023–2047)⁷³ share common sustainability objectives but lack coordinated implementation mechanisms. The ReBuilt study on the perception of nature-based construction likewise found that professionals view fragmented governance as a key obstacle to innovation in the sector.

This misalignment leads to duplicated efforts, inconsistent standards, and missed opportunities to align regulatory actions, investment priorities, and implementation mechanisms around a shared regenerative vision. Strengthening institutional coordination between the MoIT, MoENR, Ministry of Agriculture and Livestock (MoAL), MoICE, and the Gross National Happiness Center Bhutan (GNHCB) was identified as a priority to ensure that building-code reforms are complemented by supportive land-use, procurement, and industrial strategies.

⁷¹ Royal Government of Bhutan, "Thirteenth Five Year Plan" (Thimphu, 2024), [Link](#).

⁷² Ministry of Works and Human Settlement (MoWHS), "National Human Settlement Policy of Bhutan" (Thimphu, Bhutan, 2019), [Link](#).

⁷³ Ministry of Infrastructure and Transport (MoIT) et al., "Thimphu Structure Plan 2023–2047" (Thimphu, 2023).

Legal Clarity and Emerging Material Regulation

At the material level, regulatory clarity remains uneven. Timber harvesting and processing are governed by forestry regulations and guidelines, yet technical specifications for its application in modern construction are not fully integrated into building regulations. Bamboo and earth continue to rely on mostly informal standards, and industrial hemp remains legally restricted despite its ecological suitability and potential for regenerative construction.

This underscores the urgency of establishing a legal framework for industrial hemp, including clear tetrahydrocannabinol (THC) thresholds, licensing mechanisms, and quality-control procedures to distinguish it from psychoactive varieties and unlock a new regenerative value chain connecting rural production with urban construction markets.

Stakeholders further called for adaptive guidelines for bamboo and earth that ensure safety without undermining local craft traditions. Transparent and inclusive regulation of these materials would enhance investor confidence and create pathways for small enterprises to enter the formal construction economy. In parallel, the introduction of financial incentives and public procurement criteria could accelerate adoption once legal frameworks are in place.

Certification, Monitoring, and Occupational Safety

A recurring theme across all workshops was the lack of national certification and monitoring systems to ensure the safety, quality, and environmental performance of regenerative materials. Without verifiable data, builders, investors, and regulators struggle to assess reliability and compliance, perpetuating uncertainty. Establishing an integrated system for certification, monitoring, and evaluation – one that verifies materials and labour practices against ecological, social, and technical criteria – would support broader market uptake. This system should also include the professionalisation of trades through targeted training and accreditation schemes for artisans and technicians working with nature-based materials.



Fig. 3.28:
Construction workers on a
scaffolding at a construction
site in Thimphu
© Kéan Koschany, 2024

74

Kuensel, "Poor Occupational Health and Safety in the Construction Sector," Kuensel Online, June 16, 2021, [Link](#).

75

Phuntsho Dendup, "A Decade of Occupational Health and Safety in Bhutan," GNH Journal of Construction Technology & Management 2 (January 1, 2021): 23–27, [Link](#).

76

Roderick Wijunamai, "Migrant Construction Workers in Bhutan: Understanding Immigrant Flows and Their Perceptions," Rig Tshoei – Research Journal of the Royal Thimphu College 3, no. 1 (September 2020): 46–57, 52, [Link](#).

77

Department of Labour, "National OHS Strategy 2025–2035" (Thimphu, Bhutan, 2025), [Link](#).

78

Tenzing Lamsang, "13th Plan to Be Economy Focused and Responds to Mass Migration," The Bhutanese, June 15, 2024, [Link](#).

79

Yeshey Lhaden, "Government to Allocate Nu 10bn for 21st Century Skilling Programme in 13th FYP" BBS.bt, June 16, 2024, [Link](#).

Similarly important are OHS standards, as approximately 87% of fatal injuries across all industries occurred within the construction sector in 2020.

Although a range of protocols exists, their implementation and enforcement appear insufficient, and many Bhutanese construction sites are reported to have poor safety standards.⁷⁴ Industrial workers are frequently exposed to noise and air pollution, and among roughly 14,000 registered businesses nationwide, only 12% have employees trained in OHS, and only 7% have designated safety officers.⁷⁵ Additionally, about 90% of construction workers are non-Bhutanese and often face precarious working and living conditions, making them vulnerable to work-related health problems and accidents.⁷⁶

The recently published National OHS Strategy 2025–2035 recognises these challenges and proposes concrete measures to strengthen enforcement, accountability, capacity building, and public awareness around OHS across sectors.⁷⁷ To complement the proposed actions of the strategy, current frameworks should be revised and adapted to address the specific risks of working with timber, bamboo, hemp, and earth, alongside broader cross-sectoral efforts to ensure proper implementation. Strengthening these frameworks would not only protect workers but also help legitimise regenerative construction as a safe, skilled, and respected sector.

Emerging Policy Opportunities

The 13th FYP's three national programmes – the Economic Transformation Programme, the Twenty-First Century Skilling Programme, and the Economic Diversity and Resilience Programme – collectively create favourable conditions for embedding regenerative principles into national development priorities.^{78,79} As reported by The Bhutanese (2024), these programmes aim to diversify the economy, strengthen workforce capabilities, and promote green industrialisation – goals that directly align with a regenerative construction agenda. Likewise, the current TSP (2023–2047) and the development of GMC offer immediate testing grounds for demonstrating new standards and codes in practice.

Thematic Vision

Bhutan envisions a regulatory landscape where policies, standards, and planning frameworks actively guide regenerative construction practices across the built environment. Clear and inclusive regulations recognise the safety, performance, and cultural significance of nature-based materials, enabling their seamless integration into national development strategies, urban planning, infrastructure, and housing. In doing so, governance provided an enabling environment for stakeholders across entire nature-based value chains.



Fig. 3.29:
Timber depot at a FMU in Bumthang
© Bas Princen for Bauhaus Earth, 2024

Overview of Actions

Regional Opportunity 3 focuses on establishing the policy and regulatory foundations required to mainstream regenerative construction within Bhutan’s built environment. By advancing building codes, technical standards, monitoring systems, and occupational safety protocols, RO3 strengthens accountability and provides the legal clarity needed for builders, investors, and policymakers to adopt and scale regenerative approaches with confidence.

Functioning as a central enabler across the roadmap, RO3 translates the evidence generated through research and testing (RO2) and the material innovation emerging from value chains (RO1) into actionable rules and incentives that guide practice. It creates the regulatory stability necessary to expand nature-based material value chains (RO1), unlock financing mechanisms (RO4), and institutionalise education and capacity-building programmes (RO5).

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1. Update the Bhutanese Building Code to Include Timber, Bamboo, Hemp, and Earth-based Construction

Timestamp

Short Term
(2030)

Scale



Building



National

Description:

This action aims to integrate nature-based materials into the Bhutanese Building Code by developing material-specific standards, safety benchmarks, and performance guidelines. The ongoing code revision process led by the Ministry of Infrastructure and Transport provides a timely opportunity to formally recognise timber, bamboo, hemp, and earth within Bhutan's regulatory framework, offering clear parameters for their safe and effective use in construction. Embedding these standards in law will provide the necessary legal certainty for architects, engineers, insurers, and investors, enabling a shift from isolated pilot projects to widespread, mainstream application.

The action focuses on the systematic inclusion of timber, bamboo, hemp, and earth-based construction systems. While basic guidelines for earth-based materials already exist, new and more comprehensive provisions are required for timber, bamboo, and hemp to ensure compliance with structural integrity, fire safety, seismic resilience, and energy-performance requirements.

Developing these standards will require close collaboration with national research institutions, testing facilities, and industry stakeholders to ensure that regulatory criteria reflect Bhutan's climatic conditions, resource availability, and safety needs. This effort is closely connected to other roadmap areas – particularly the generation of material performance data and the development of nature-based value chains under Regional Opportunity 1 – which will provide the evidence base necessary for codifying safe and scalable applications of these materials.

Key Intervention Fields:

- Enabling Policy Frameworks

- Material Transition

- Building Practices and Culture

Stakeholders:

- Department of Human Settlement

- Department of Forests and Park Services

- Department of Infrastructure Development

- Department of Geology and Mines

- Bhutan Standards Bureau

- College of Science and Technology

- College of Natural Resources

- Construction Association of Bhutan

- Research and Testing Institutes

Impact

- Provides formal regulatory recognition for nature-based construction materials, enabling their safe, legal, and consistent integration into mainstream building practice.
- Supports the transition from isolated pilot projects to widespread application through codified standards, clear approval pathways, and certification frameworks.
- Strengthens investor, insurer, and public confidence by establishing transparent safety, performance, and compliance benchmarks.
- Reduces Bhutan's dependency on imported, emission-intensive construction materials, reinforcing national self-sufficiency and lowering embodied carbon.

Trade-offs

- Developing new standards requires time, technical expertise, and financial resources, which may delay widespread adoption in the short term.
- Successful uptake will require parallel efforts to address market perceptions and demonstrate the economic feasibility of nature-based materials.
- Risk of overly restrictive or inappropriate regulations if codes are not carefully adapted to Bhutan's diverse settlement patterns, vernacular practices, and climatic conditions.
- Potential tension may arise between traditional building practices and formalised standards if local knowledge systems and building practices are not adequately represented in the regulatory process.

2. Legalise and Regulate Industrial Hemp Production for Regenerative Construction

Timestamp

Short Term
(2030)

Scale



Material



National

Description:

This action focuses on establishing the legal and regulatory foundations for the cultivation, processing, and use of industrial hemp as a regenerative building material in Bhutan, addressing the current absence of a framework that restricts its production and market development. The first step is to legalise industrial hemp by formally distinguishing it from psychoactive cannabis, setting THC thresholds in alignment with international standards (0.2 - 0.3%), and defining clear licensing mechanisms for cultivation, processing, and distribution. These regulatory provisions would be developed under the oversight of the Ministry of Agriculture and Livestock (MoAL) in coordination with relevant national agencies to ensure controlled, transparent, and sustainable value chain development.

Once legal clarity is established, subsequent regulations and standards will guide the processing, testing, and quality assurance of hemp-based building materials. These measures will be integrated into the Bhutanese Building Code to ensure compliance with structural safety, durability, and environmental performance. Establishing such a regulatory foundation will create the necessary foundations for pilot projects, research investments, and private-sector engagement, linking directly to ongoing initiatives under RO1 (Action 3) and RO3 (Action 1). Together, these measures will enable Bhutan to develop a well-regulated, evidence-based hemp sector that supports both regenerative construction and rural economic diversification.

Key Intervention Fields:

● Enabling Policy Frameworks

● Material Transition

Stakeholders:

● Bhutan Food and Drug Authority

● Department of Agriculture

● Department of Forests and Park Services

● Department of Infrastructure Development

● Department of Human Settlement

● Construction Authority of Bhutan

● College of Science and Technology

Impact

- Creates institutional clarity and regulatory stability, enabling long-term planning and investment in hemp-based building materials.
- Strengthens policy coherence between agriculture, industry, and construction by linking rural production systems with urban material demand.
- Encourages innovation and private-sector participation within emerging low-carbon material markets.
- Promotes sustainable agriculture and enhances rural livelihoods by supporting diversified and resilient local economies.

Trade-offs

- Requires substantial upfront research, testing, and monitoring to validate the viability of locally available hemp and its long-term potential for agriculture and construction.
- Legislative and institutional complexity may delay the rollout of cultivation and processing licenses, particularly during early regulatory transition phases.
- Strict regulatory oversight, if not designed with accessibility in mind, may create barriers for smallholder farmers and community-based producers, limiting equitable participation.

3. Integrate Regenerative Practices into Cross-Sectoral Policies and Strategies

Timestamp

Short Term
(2030)

Scale



Regional



National

Description:

This action seeks to embed regenerative construction principles across Bhutan's wider policy and planning landscape by integrating measurable targets, performance benchmarks, and sector-specific commitments into national frameworks such as the upcoming 14th FYP and the revised Nationally Determined Contributions (NDCs). Regenerative principles should be explicitly reflected within sectoral strategies – including affordable housing, tourism development, natural resource management, and economic diversification – to ensure that environmental ambitions are coherently linked with the planning, design, and operation of the built environment. Aligning these frameworks will promote cross-sectoral coordination, provide clear implementation pathways, and reinforce Bhutan's commitment to a carbon-neutral and socially inclusive development trajectory.

In the housing sector, this entails supporting cost-effective, culturally grounded, and ecologically restorative building solutions that integrate passive design, nature-based materials, circularity, and Bhutanese architectural traditions. Regenerative approaches should likewise inform urban systems planning, including rainwater harvesting, landscape-based stormwater management, greywater reuse, and the incorporation of green and blue infrastructure in both public and private developments. Environmental and agricultural agendas can be leveraged to link natural resource stewardship with the production and supply of bio-based construction materials, strengthening synergies between rural resource economies and urban development needs. The tourism sector offers an immediate opportunity to demonstrate regenerative design through eco-lodges, heritage conservation projects, and nature-based visitor infrastructure.

Key Intervention Fields:

- Enabling Policy Frameworks

- Ecosystem Care

- Socio-Spatial Equity

- Economic Innovation

- Building Practices and Culture

Stakeholders:

- National Assembly of Bhutan

- Cabinet Secretariat

- Ministry of Infrastructure and Transport

- Ministry of Agriculture and Livestock

- Ministry of Energy and Natural Resources

- Ministry of Health

- Ministry of Finance

- Ministry of Home Affairs

- Ministry of Industry, Commerce, and Employment

- Ministry of Education and Skills Development

Impact

- Positions regenerative construction as a cross-cutting national priority, aligning built-environment strategies with broader environmental and social goals and reinforcing Bhutan's leadership in sustainable development.
- Aligns affordable housing objectives with regenerative design principles, improving socio-spatial equity and access to healthy, climate-responsive living environments.
- Stimulates local employment across rural supply chains, bio-based material production, and nature-based tourism infrastructure.
- Expands Bhutan's international visibility as a demonstration case for integrated policy frameworks that connect construction, environmental stewardship, and cultural heritage.

Trade-offs

- Requires complex cross-sectoral coordination, which may lead to delays, policy dilution, or unclear accountability without strong leadership.
- Risks remaining symbolic rather than transformative if regenerative goals are not supported by measurable targets, implementation pathways, and dedicated funding.
- Because supply chains for regenerative materials are still emerging, integrating them into large-scale housing, infrastructure, or tourism programmes may outpace current production capacity and strain material availability.

4. Strengthen and Enforce Occupational Health and Safety Protocols

Timestamp

Medium Term
(2040)

Scale



Building



National

Description:

This action focuses on reviewing and strengthening OHS standards across Bhutan's emerging nature-based material value chains, complementing ongoing efforts outlined in the new National OHS Strategy 2025-2035. Updating existing frameworks will ensure that the specific risks associated with the harvesting, processing, transporting, and construction with timber, bamboo, hemp, and earth are properly addressed. Revised protocols will be developed through collaboration among relevant ministries, vocational institutions, and industry stakeholders, identifying material-specific hazards and translating them into practical, enforceable safety guidelines.

In parallel, the action will prioritise capacity building through hands-on training, workplace demonstrations, and targeted awareness programmes for both employers and workers. Establishing monitoring, reporting, and evaluation mechanisms will help ensure consistent implementation and support continuous improvement.. By integrating OHS standards early – alongside the development of new value chains – this action embeds safe, fair, and dignified working conditions as a foundational element of Bhutan's transition towards regenerative construction.

Key Intervention Fields:

- Enabling Policy Frameworks

- Building Practices and Culture

- Capacity Strengthening

Stakeholders:

- Department of Labour

- Department of Human Settlement

- Department of Infrastructure Development

- Department of Forests and Park Services

- Construction Authority of Bhutan

- College of Science and Technology

- Professional Associations

Impact

- Increases the attractiveness of construction-sector jobs by ensuring safer, more dignified working conditions aligned with Bhutan's socio-ecological development commitments.
- Empowers workers to actively contribute to workplace safety through clear guidelines, practical training, and strengthened reporting mechanisms.
- Reduces costs associated with accidents and injuries for contractors, companies, and public agencies by lowering downtime, medical expenses, and liability risks.
- Improves project management and reduces unexpected delays, as safer and more organised worksites lead to fewer disruptions and higher productivity.
- Builds a safe, skilled and stable workforce, resulting in higher-quality workmanship and greater professional pride across the construction sector.

Trade-offs

- Time-intensive co-development processes, as aligning interests among ministries, industry stakeholders, workers, and training institutions may involve negotiation, conflicting priorities, and iterative consensus-building.
- Increased administrative burden for contractors and firms due to expanded compliance, reporting, and monitoring requirements.
- Potential competitive disadvantage for small firms, which may struggle to absorb additional compliance costs or invest in safety personnel and equipment.
- Risk of fostering a culture of minimal compliance, where firms focus on meeting the basic requirements to avoid penalties rather than proactively improving safety standards.

5. Establish National Systems for Monitoring, Evaluation, and Certification of Regenerative Construction Materials and Practices

Timestamp

Long Term
(2050)

Scale



Regional



National

Description:

This long term action focuses on establishing an integrated national framework for certification, monitoring, and evaluation that formally recognises nature-based materials and regenerative building practices as viable, safe, and high-performing components of Bhutan's construction sector. The certification system will define clear standards across ecological, economic, and socio-cultural dimensions – covering material sourcing, processing, structural integrity, fire and seismic safety, and environmental performance. Complemented by targeted training and accreditation programmes, it will professionalise work with timber, bamboo, hemp, and earth while strengthening the skills base needed for industry-wide adoption. By verifying compliance with social, environmental, and technical safeguards, the system will build confidence among builders, investors, and policymakers, ensuring consistent quality and enhancing public trust in the safety, legitimacy, and long-term reliability of regenerative construction in Bhutan.

Complementing this, a robust monitoring and reporting mechanism will be established to track production quality, processing compliance, and the use-in performance of certified materials and building systems. Designed to be data-driven and verifiable, this mechanism will ensure that sustainability and safety standards are consistently met, while enabling continuous refinement through feedback loops between practice, policy, and research. Over time, certified materials and accredited labour could become prerequisites for public procurement and regulatory approval, reinforcing a culture of transparency, accountability, and continuous improvement across Bhutan's regenerative construction sector.

Key Intervention Fields:

- Enabling Policy Frameworks
- Capacity Strengthening

Stakeholders:

- Department of Human Settlement
- Department of Infrastructure Development
- Technical Training and Vocational Education Institutions
- Bhutan Standards Bureau
- College of Science and Technology
- National Housing and Development Corporation Ltd.

Impact

- Supports the integration of regenerative construction practices into national standards, public procurement frameworks, and planning processes, reinforcing long-term sector transformation.
- Enhances confidence and transparency in the use of nature-based materials through verifiable quality and performance standards.
- Strengthens professional skills and safety by establishing certified training pathways and labour accreditation for regenerative construction.
- Encourages investment and broader market uptake by reducing perceived risks for builders, developers, and financiers.

Trade-offs

- Establishing certification systems, testing protocols, and training programmes requires substantial upfront investment and long lead times before full functionality is achieved.
- Certified materials and trained labour may raise short-term costs for small-scale builders and enterprises if market demand and supportive incentives do not grow in parallel.
- Overly rigid or prescriptive certification frameworks may inadvertently hinder innovation, experimentation, and context-specific development – particularly during the early stages of Bhutan's regenerative construction transition.

Regional Opportunity 4



Fig. 3.30:
Thimphu Valley
© Bas Princen for Bauhaus Earth, 2024

Harness urban growth and development projects – such as Thimphu-Paro and the Gelephu Mindfulness City – to catalyse value chains, diversified job opportunities, and direct investment flows towards regenerative construction

Background and Problem Statement

Building on its national commitments to social well-being, environmental stewardship, and low-carbon development, Bhutan envisions a transition towards a regenerative construction sector. Yet this ambition is currently constrained by the absence of an enabling financial and market environment. While national policies increasingly emphasise low-carbon and sustainable development, the economic structures required to attract and sustain investment specifically in regenerative and nature-based construction remain underdeveloped.

Conventional construction continues to dominate Bhutan's market because it benefits from well-established supply chains, standardised materials, predictable cost structures, and lender familiarity. By contrast, regenerative construction and planning approaches – grounded in nature-based materials, circular practices, and local value chains – faces higher perceived risks due to limited performance data, emerging standards, and nascent markets. As a result, access to finance, credit, and investment for nature-based construction remains restricted, slowing the sector's growth despite its environmental, social, and economic potential.

At present, no publicly documented financing instruments or credit lines target regenerative or low-carbon construction. Although Bhutan's forthcoming green finance taxonomy aims to align national investment flows with sustainability objectives, it has not yet been translated into operational incentives for the built environment. Existing loans, insurance products, and procurement policies continue to evaluate construction projects, which favour familiar, standardised materials and discourage engagement with emerging nature-based alternatives.

As a consequence, pioneering regenerative initiatives – such as the mass-timber multi-storey project along Norzim Lam or Royal Academy buildings) – rely heavily on short-term donor funding or project-based grants. This dependence limits continuity, restricts learning, and hampers the potential for scaling.

The financial challenge is further compounded by limited data and cost transparency. Without consistent information on the costs, performance, and life-cycle economics of nature-based materials, investors and lenders struggle to evaluate their competitiveness or manage risk. Builders likewise face high upfront expenses for planning, sourcing, testing and processing, particularly in the absence of domestic standards or certification systems that could verify performance and reduce uncertainty. These gaps reinforce

the perception that regenerative construction is costly or experimental, rather than a viable and economically competitive alternative to conventional building approaches.

Further, market demand for regenerative construction remains weak. Bhutan's Green Building Guidelines and Green Public Procurement (GPP) frameworks provide important reference points, yet both remain voluntary. As a result the public-sector – the country's largest potential client and market-shaper – has not yet created meaningful demand for nature-based building materials. Without binding procurement criteria, fiscal incentives such as tax rebates, or concessional loan products, private developers have little motivation to shift away from conventional construction. In this environment, nature-based projects remain isolated prototypes rather than emerging as viable, market-driven enterprises.

At the same time, ongoing urban growth in the Thimphu-Paro region and the planned GMC present a unique opportunity to reverse this trend. These developments will drive substantial demand for housing, public facilities, and infrastructure over the coming decades. If strategically directed, this expansion could become a catalyst for investment, employment, and domestic enterprise development across regenerative material value chains.

Public procurement and urban planning that prioritise nature-based construction could create predictable markets, stimulate rural production systems, and anchor job creation in Bhutan's local economies. By steering urbanisation along regenerative principles, the construction sector could emerge not only as a major emitter to be addressed, but as a key driver of inclusive, circular, and low-carbon economic growth.

In summary, Bhutan's transition towards regenerative construction is constrained by interlinked barriers: limited access to tailored finance, insufficient cost and performance data, weak market incentives, and an emerging industry that has yet to reach commercial maturity. Yet the pace of urban development presents a timely opportunity to shift this trajectory. By aligning fiscal policy, public procurement, industrial investment, and the creation of safe and well-paid jobs with regenerative value chains, Bhutan can position its construction sector as a driver of inclusive, low-carbon economic transformation.

Project Findings

Early-Stage Investment

Stakeholder consultations consistently emphasised that Bhutan's transition to regenerative construction will require a fundamental shift in how capital is mobilised, distributed, and de-risked. Across discussions, there was broad agreement on the need of early-stage financing instruments that can bridge the gap between experimentation and market adoption. Proposed mechanisms included co-financed demonstration projects, blended investment models, and flexible grant-loan schemes that enable entrepreneurs and small manufacturers to enter nature-based material markets. Participants also stressed that investment in research, testing, and industrial infrastructure must precede large-scale market uptake. Establishing robust technical and economic evidence is essential for reducing perceived risk and enabling private capital to engage with confidence.

Market Stimulation and Public Procurement

Public procurement was widely recognised as the most direct policy lever to generate stable demand and signal legitimacy to investors and contractors. Participants envisioned a coordinated fiscal approach in which government-backed incentives align with urban planning, housing, and infrastructure programmes, ensuring that regenerative materials become economically competitive. Such targeted measures were seen as a precondition for establishing a self-sustaining market capable of attracting both domestic and external investment.

Fig. 3.31 (left):
Trucks transporting timber
logs for export in Bumthang
© Kéan Koschany, 2024

Fig. 3.32 (right):
Wooden planks strung for
seasoning at private saw mill
in Bumthang
© Kéan Koschany, 2024



Industrial and Value-Chain Readiness

Alongside financial innovation, workshop discussions highlighted the need for industrial consolidation and stronger, more coordinated value chains. Participants acknowledged that Bhutan's industrial base for regenerative materials is still nascent but noted increasing institutional momentum. The planned timber testing facility to be established by DHI and CST is regarded as a critical catalyst for establishing technical credibility, improving quality assurance, and building investor confidence.⁸⁰

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Druk Holding & Investments Ltd., "DHI and CST Partner to Establish Bhutan's First Structural Timber Testing and Research Facility," [Www.dhi.bt](https://www.dhi.bt), February 11, 2025, [Link](#).

Stakeholders consistently identified timber as the most mature value chain for near-term scaling, while bamboo and hemp were viewed as promising mid-term opportunities that would require enabling policies, regulatory reform, and targeted financial incentives to reach commercial viability. Strengthening these value chains would not only diversify Bhutan's rural economy but also reinforce connections between sustainable resource management and national industrial development.

Urban Growth as a Strategic Catalyst

Beyond the direct outcomes of stakeholder engagement, research findings highlight Bhutan's current urban growth dynamics – particularly in the Thimphu-Paro region and GMC – as powerful levers for scaling regenerative construction. These developments are expected to generate substantial demand for housing, infrastructure, and public facilities in the coming decade. The TSP estimates the construction of approximately 48,000 new homes in the capital over the next 22 years,⁸¹ while the GMC development is envisioned to accommodate up to 1 million citizens once fully built.⁸² Together, these expansion areas create significant and predictable demand markets that could be strategically leveraged to accelerate the adoption of nature-based construction materials and regenerative approaches across Bhutan's built environment.



Fig. 3.33:
Thimphu Valley
© Kéan Koschany, 2024

If strategically guided, this expansion could serve as a catalyst for investments, job creation, and enterprise development across nature-based construction value chains. Embedding regenerative building principles into large-scale public and private developments would not only generate predictable demand for locally sourced materials but also demonstrate their technical performance and cost-effectiveness at scale. By harnessing urbanisation in this way, Bhutan can align its growth trajectory with domestic value creation and circular economic principles – positioning the construction sector as a driver of both ecological resilience and inclusive economic development.

⁸¹ Ministry of Infrastructure and Transport (MoIT) et al., "Thimphu Structure Plan 2023-2047" (Thimphu, 2023): 21.

⁸² Gelephu Mindfulness City (GMC), "Gelephu Mindfulness City," Gmc.bt, 2024, [Link](#).

Towards a Regenerative and Inclusive Investment Ecosystem

Looking ahead, Bhutan's shift towards a regenerative construction economy will depend not only on establishing a coherent and well-coordinated investment ecosystem but also on ensuring that these investments translate into meaningful and dignified employment. The construction sector holds significant potential for green job creation – particularly in local manufacturing, material processing, and regenerative building services.

Yet, current labour market and out-migration dynamics reveal a widening disconnect between available employment and the aspirations of Bhutan's working population. Limited private-sector opportunities have contributed to accelerating outmigration in recent years, with young and educated professionals making up roughly one third of international migrants. In 2022, youth unemployment reached 37% among those aged 15–19 and 27% in the 20–24 age group, compared to a national average of 6%.⁸³

To counter this trend, investments in regenerative construction should be positioned as a catalyst for green, safe, and well-paid employment that attracts and retains domestic talent while creating viable pathways for Bhutanese abroad to return. A coordinated approach – linking government, financial institutions, academia, and private industry – is essential to build an ecosystem where capital mobilisation, skills development, and industrial innovation reinforce one another. Aligning investment flows with human-capital development and transparent monitoring systems will be critical to transform the challenge of brain drain into an opportunity: one where a transition to a low-carbon, nature-based built environment simultaneously strengthens socio-economic resilience across the country.

The research findings highlight that the envisioned transformation will depend on establishing clear mechanisms for collaboration across ministries and sectors, particularly between the Ministry of Finance (MoF), MoIT, DHI, and domestic financial institutions such as the Bhutan Development Bank Ltd. (BDBL) and the Bhutan National Bank (BNB). Fiscal and procurement incentives will be essential to create a stable initial market for regenerative construction, while de-risking instruments – including guarantees, co-financing arrangements, and evidence generated through demonstration projects – can help attract early private investment. Over the longer term, innovative financing mechanisms such as blended funds and revolving credit lines could support sector-wide scaling and foster circular business models, ensuring sustained investment in regenerative material value chains.

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Jumana Alaref et al., "Bhutan Labor Market Assessment Report," 2024, 8, [Link](#).

Thematic Vision

Bhutan envisions an investment landscape in which finance becomes a catalyst for a regenerative built environment. Public and private capital flow strategically into local enterprises, research institutions, and infrastructure that reinforce nature-based value chains and create green, dignified employment. Transparent governance, coherent policy signals, and well-aligned incentives foster investor confidence, while financial innovation bridges Bhutan's tradition of environmental stewardship with contemporary sustainability goals. In this future, Bhutan's construction economy stands as a model of regenerative development – rooted in local value creation, circular economic principles, and long-term climate responsibility.



Fig. 3.34:
Wooden staircase in traditional rural house, Thimphu
© Bas Princen for Bauhaus Earth, 2024

Overview of Actions

Regional Opportunity 4 mobilises finance and investment as central levers for Bhutan’s transition towards regenerative construction and creates the conditions for capital to flow reliably towards nature-based materials, circular materials, and regenerative planning approaches. Acting as the financial and institutional bridge across the entire roadmap, RO4 provides the stable investment ecosystem required for the success of actions under all other ROs. It builds on the regulatory clarity and risk reduction generated through policy reform (RO3), leverages the technical evidence and innovation capacity developed through research and innovation (RO2), and amplifies the competitiveness of the nature-based material value chains advanced under RO1. Through this alignment, RO4 ensures that Bhutan’s regenerative construction transition is supported by coherent, long-term, and scalable financial pathways.

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1. Set-up a Multi-stakeholder Investment Roundtable and Advisory Committee

Timestamp

Short Term
(2030)

Scale



Regional



National

Description:

This action proposes a two-tier coordination mechanism to better align public, private, and blended finance with Bhutan's regenerative construction agenda. The first tier establishes a multi-stakeholder investment roundtable, bringing together representatives from government agencies, financial institutions, development partners, civil society, and the private sector. Serving as a participatory forum, the roundtable will facilitate knowledge exchange, identify shared investment priorities, and develop strategies to scale nature-based construction across both urban and in rural contexts. By enabling open dialogue and joint problem-solving, it will strengthen evidence-based decision-making and ensure that the perspectives of local actors, innovators, and entrepreneurs meaningfully shape national investment directions.

On the other hand, a high-level investment advisory committee will translate the roundtable's insights into actionable financing pathways. Composed of key institutional actors from the finance, infrastructure, and industry sectors, the committee will provide technical and policy guidance on structuring investment vehicles, designing de-risking mechanisms, and coordinating resource mobilisation across government and private partners. By harnessing the momentum of Bhutan's major urbanisation processes – particularly in the Thimphu-Paro region and GMC – the committee will position large-scale developments as catalysts for channeling finance into regenerative construction value chains. Together, the roundtable and advisory committee will create a continuous feedback loop between inclusive participation and expert decision-making, establishing the stable conditions needed for capital to flow towards a regenerative built environment.

Key Intervention Fields:

- Economic Innovation
- Enabling Policy Frameworks
- Collaborative Governance

Stakeholders:

- Ministry of Infrastructure and Transport
- Ministry of Finance
- Ministry of Industry, Commerce, and Employment
- Ministry of Energy and Natural Resources
- Druk Holding and Investments Ltd.
- Royal University of Bhutan
- National Housing Development Corporation Ltd.
- Domestic Banks and Funds
- Industry Stakeholders
- International Organisations and Donors
- Civil Society

Impact

- Increases predictability and stability within the investment environment, encouraging long-term capital commitments in regenerative construction.
- Positions major urban developments as demonstration grounds for scalable regenerative investment models.
- Fosters a culture of collaboration and knowledge exchange between public, private, and financial actors, improving coordination across Bhutan's investment landscape.
- Builds financial literacy and capacity among local enterprises, innovators, and entrepreneurs, generating wider spill-over benefits across the economy.
- Strengthens domestic and international confidence in Bhutan's green finance agenda, expanding access to new funding sources.

Trade-offs

- Sustaining two interconnected coordination bodies will require continuous facilitation, administrative resources, and strong long-term institutional commitment.
- Reliance on large urban projects to catalyse investment may inadvertently overshadow or underfund smaller-scale regenerative initiatives in rural areas.
- Risk of over-representation of well-connected or urban stakeholders, potentially marginalising rural voices or smaller enterprises.

2. Create Targeted Public, Private, and Blended Financing Programmes

Timestamp

Medium Term
(2040)

Scale



National

Description:

Designing dedicated public and blended financing mechanisms is crucial to accelerating investment in Bhutan's regenerative construction sector. Instruments such as concessional bank loans, revolving credit lines, credit guarantees, and sector-specific development funds can reduce financial barriers for enterprises and developers adopting nature-based materials and circular construction practices. By lowering upfront costs and sharing risk, these mechanisms will not only provide accessible capital but also help de-risk pioneering projects, encouraging private-sector participation in solutions that might otherwise be perceived as unfamiliar or high-risk.

To maximise their effectiveness, financing schemes should be co-designed by government agencies, financial institutions, and development partners, and guided by the multi-stakeholder roundtable and advisory committee established under RO4, Action 1. This coordinated approach will ensure that financial instruments align with Bhutan's socio-ecological priorities and broader development objectives. Clear eligibility criteria – tied to measurable environmental performance, social benefits, and cultural stewardship – will further reinforce the sector's contribution to carbon neutrality, employment generation, and the preservation of Bhutan's built heritage.

Key Intervention Fields:

- Economic Innovation
- Enabling Policy Frameworks
- Collaborative Governance

Stakeholders:

- Multistakeholder Investment Roundtable and Advisory Committee (RO4, Action 1)
- Ministry of Finance
- Ministry of Industry, Commerce, and Employment
- Druk Holding and Investments Ltd.
- Royal Monetary Authority
- Ministry of Infrastructure and Transport
- National Housing Development Corporation Ltd.
- Domestic Banks and Funds
- Regional Development Finance Institutions
- International Organisations and Donors

Impact

- Expands access to affordable finance for small and medium-sized enterprises engaged in nature-based material production and regenerative construction services.
- Creates predictable and stable funding streams that support long-term planning, innovation, and scaling of regenerative construction projects.
- Sends a strong policy signal that can attract co-financing from international climate, biodiversity, and development funds.
- Enhances investor confidence and trust by demonstrating government commitment, clear eligibility criteria, and transparent governance of green finance mechanisms.
- Builds the capacity of domestic financial institutions by strengthening expertise in sustainable lending, green finance instruments, and risk assessment for emerging material markets.

Trade-offs

- Requires significant institutional capacity administration, monitoring, and verification to ensure funds are used effectively.
- Aligning financial returns with socio-ecological safeguards may reduce attractiveness for certain private investors seeking short-term profit, potentially limiting participation without complementary incentives.
- Risk of misallocation or elite capture if eligibility criteria, evaluation processes, and reporting mechanisms are not transparent or robustly enforced.
- Early beneficiaries may disproportionately be larger or better-resourced firms unless specific provisions are designed to prioritise SMEs, community enterprises, and rural producers.

3. Offer Financial Incentives for Early Adopters

Timestamp

Medium Term
(2040)

Scale



National

Description:

Introducing targeted incentive schemes can accelerate the early adoption of regenerative building practices before regulatory frameworks and certification systems are fully established. Instruments such as tax rebates, direct grants, and preferential loan terms will reduce the upfront costs and perceived risks for enterprises, developers, and contractors that choose to integrate nature-based materials and regenerative design principles ahead of mandates. By creating a first-mover advantage, these incentives encourage innovation, demonstrate feasibility at scale, and stimulate market demand. By creating a first-mover advantage, these incentives encourage innovation, demonstrate feasibility at scale, and stimulate early market demand.

To maximise impact, financial incentives should be strategically aligned with public procurement priorities (RO4, Action 4) and linked to pilot and demonstration programmes (RO5, Action 3). This combined approach can create predictable demand, support evidence generation, and ensure that early adopters help build the technical and economic foundation for Bhutan's wider transition to regenerative construction.

Well-designed incentive schemes also generate strong signalling effects, demonstrating clear government commitment to regenerative and culturally grounded construction. Such signals can mobilise private-sector participation, build investor confidence, and stimulate positive competition among developers to align with Bhutan's socio-ecological priorities. Over time, these incentives help establish a critical mass of projects, enterprises, and practitioners, creating the market maturity and technical experience needed for broader reforms. This early momentum will enable future regulatory standards to be introduced more smoothly and with stronger acceptance across the sector.

Key Intervention Fields:

- Economic Innovation
- Enabling Policy Frameworks
- Collaborative Governance

Stakeholders:

- Multistakeholder Investment Roundtable and Advisory Committee (RO4, Action 1)
- Ministry of Finance
- Ministry of Industry, Commerce, and Employment
- Druk Holding and Investments Ltd.
- Royal Monetary Authority
- Ministry of Infrastructure and Transport
- National Housing Development Corporation Ltd.
- Domestic Banks and Funds

Impact

- Encourages innovation by reducing the financial and technical risks associated with piloting untested materials and technologies.
- Accelerates market uptake of regenerative construction practices by providing rewards and advantages for early adopters.
- Builds a portfolio of early demonstration projects that generate evidence, improve investor confidence, and support regulatory development.
- Sends a strong policy signal that aligns private-sector incentives with Bhutan's climate, cultural, and development priorities.
- Stimulates innovation and healthy competition among entrepreneurs, start-ups, and established firms.

Trade-offs

- Requires fiscal resources that may be limited or may face competition from other national priorities.
- Risk that benefits disproportionately accrue to larger or better-capitalised firms unless schemes are intentionally designed to include SMEs and rural enterprises.
- Possibility of "greenwashing" if eligibility, verification, and reporting criteria are insufficiently robust or inconsistently enforced.
- May create uneven market conditions if incentives are not applied equitably across regions, material value chains, or project types.

4. Prioritise Regenerative Construction in Public Procurement

Regional Opportunity 4

Timestamp



Short Term
(2030)

Scale



Building



National

Description:

Embedding regenerative construction criteria into public procurement processes is a powerful lever to create stable demand and stimulate wider market uptake. By rewarding the use of nature-based materials and regenerative design principles in public buildings, infrastructure, and urban renewal projects, the Bhutanese government can set clear benchmarks for quality, performance, and sustainability. Such measures will signal to industry that regenerative construction is not a niche experiment but a national priority, thereby encouraging private sector actors to invest in capacity and innovation.

Public procurement can also serve as a demonstration of good practice, showcasing visible, high-impact projects across sectors and building typologies to strengthen public trust and awareness. By aligning procurement frameworks with Bhutan's carbon-neutrality and cultural preservation goals, the country ensures that public investment delivers multiple co-benefits, including job creation, ecological stewardship, and greater resilience in the built environment. Over time, procurement standards will help normalise regenerative practices across sectors, anchoring them as the default approach for both public and private developments.

Key Intervention Fields:

- Economic Innovation
- Enabling Policy Frameworks
- Building Practices and Culture

Stakeholders:

- Ministry of Infrastructure and Transport
- Ministry of Finance
- Ministry of Industry, Commerce, and Employment
- Ministry of Energy and Natural Resources
- Public Institutions
- State-owned Enterprises

Impact

- Creates guaranteed demand for regenerative construction materials and practices, providing market stability and confidence for local enterprises.
- Demonstrates leadership by turning public projects into visible showcases of regenerative building practices.
- Encourages private sector alignment as suppliers and contractors adapt to meet procurement criteria.
- Strengthens domestic value chains by prioritising local, sustainably sourced materials.
- Ensures that public expenditure simultaneously advances climate, employment, and cultural objectives.

Trade-offs

- Requires significant administrative effort and training for officials.
- Risk of higher costs for public projects if regenerative materials or methods are not yet available at scale.
- Creates barriers to entry if criteria are too stringent without parallel capacity-building efforts.
- Ensuring robust monitoring and enforcement of procurement standards may strain institutional capacities.

5 Regional Opportunity 4 Leverage Regional and Global Funds for Regenerative Construction

Timestamp



Long Term
(2050)

Scale



National

Description:

Leveraging regional and global climate and adaptation funds can provide a critical boost to Bhutan's regenerative construction sector by mobilising external finance for scaling nature-based building practices. Systematic assessments of pilot and demonstration projects will generate the evidence needed to refine business models, demonstrate cost-effectiveness, and strengthen investment cases for regenerative construction. By showcasing tangible outcomes – such as reduced emissions, enhanced resilience, and socio-economic benefits – Bhutan can position its construction sector within broader low-carbon development pathways recognised by international finance institutions.

Building on this evidence, Bhutan can proactively engage with regional and global funding mechanisms, including the Green Climate Fund, Adaptation Fund, Global Environment Facility, and bilateral or multilateral climate initiatives. While Bhutan's graduation from Least Developed Country (LDC) status in 2023 changes its eligibility for some concessional support, the country can leverage its proven environmental stewardship, climate-vulnerability profile, and track record in sustainable development to access funding targeted at climate resilience, low-carbon innovation, and nature-based solutions.

Key Intervention Fields:

- Economic Innovation

Stakeholders:

- Ministry of Infrastructure and Transport
- Ministry of Finance
- Ministry of Industry, Commerce, and Employment
- Ministry of Energy and Natural Resources
- Public Institutions
- State-owned Enterprises

Impact

- Sustains market growth, de-risks innovative enterprises, and provides long-term, risk-mitigated capital to scale regenerative construction practices.
- Positions Bhutan as a regional model by linking regenerative construction to global low-carbon development pathways.
- Generates green employment opportunities and strengthens domestic research and innovation capacity.

Trade-offs

- Dependence on external funding may limit flexibility in project design and prioritisation of local needs.
- Global funds often have long approval timelines, which may slow down project implementation.
- Securing global funds is administratively demanding, with complex application and reporting requirements that may strain institutional capacity.
- Heavy reliance on international finance risks creating dependency if domestic financing ecosystems are not developed in parallel.

Regional Opportunity 5



Fig. 3.25
Sawmill, Thimphu
© Sas Prinsen for Bauhaus Earth 2019

Utilising local and global knowledge to build national capacities, expand skilling opportunities, and increase demand for nature-based building materials

Background and Problem Statement

Building the foundation for a regenerative construction sector in Bhutan requires more than technological innovation or policy frameworks. It also depends on human capacities, cultural knowledge, and social legitimacy. Domestic skills development, professional training, and public awareness are crucial to ensuring that regenerative construction practices can be implemented at scale and foster long-term sectoral resilience.

Capacity gaps and fragmented awareness remain some of the most pressing challenges for Bhutan's transition. Traditional construction techniques using timber, bamboo, rammed earth, or stone carry deep socio-ecological benefits, yet they are often undervalued compared to modern, carbon-intensive construction methods. This erosion of cultural knowledge coincides with scepticism among contemporary construction stakeholders. Regenerative construction practices are frequently perceived as either expensive, high-end solutions suited only for niche projects, or as low-income, rural housing approaches.

On a technical level, nature-based construction is often viewed as unsuitable for disaster-resilient applications or assumed to have low resistance to weathering. Such perspectives undermine confidence and trust in nature-based solutions and limit demand, even when these materials can competitively deliver on sustainability, performance, resilience, and cultural identity.

This lack of awareness and knowledge contributes to a continued reliance on conventional, carbon-intensive building systems. While a few pioneers and early adopters are emerging in Bhutan, innovators and demonstration projects remain isolated and lack platforms for visibility and knowledge exchange. These standalone initiatives are valuable for raising consumer awareness but cannot compensate for the absence of broader public- or private-sector driven efforts to advance regenerative construction. Moreover, many contemporary regenerative construction projects rely heavily on international collaborations, often without sufficient capacity-building for local communities and professionals – an essential requirement for initiating transitions at scale.

At the same time, Bhutan's education and training systems provide limited exposure to regenerative building principles, with vocational and higher-education curricula only beginning to address gaps in technical literacy and professional capacity. Without sustained initiatives, future generations of builders, architects, and engineers risk graduating without the skills needed to design and deliver regenerative built environments.



Fig. 3.36:
Local artisan painting the
timber structure of a new
building
© Kéan Koschany, 2024

Additional information on market demand, user perceptions, and uptake barriers would further enable policymakers and private actors to engage more effectively with the opportunities and challenges facing regenerative construction.

It is therefore necessary to create new pathways for capacity building, awareness, and professional training while fostering collaborative action and knowledge exchange among relevant stakeholders both locally and globally. Achieving this will require an enabling environment for domestic innovation and thoughtful collaboration with local and international expertise. Increased awareness, together with supportive policies as outlined in RO3, can stimulate consumer-driven demand and, in turn, accelerate the mainstream adoption of nature-based materials in Bhutan’s construction sector.

Project Findings

Expanding Regenerative Knowledge and Institutional Learning

Local stakeholders agreed that Bhutan's regenerative construction transition hinges on the ability to generate, share, and institutionalise knowledge. Early discussions highlighted the absence of a central mechanism to connect research institutions, government agencies, and practitioners, resulting in fragmented information flows and missed opportunities for collaboration. Insights from the research also emphasise the need for systematic research coordination and data management to ensure that findings from pilots and studies inform both policy and education. Participants proposed a national knowledge platform to consolidate lessons from demonstration projects, traditional practices, and scientific research – helping to align training programmes, standards, and regulatory frameworks.

Such a platform was envisioned to serve as a coordination and learning interface linking the MoIT, CST, and partners such as DHI. Its functions would include curating data on material performance and market demand, documenting ongoing pilots, integrating research into curricula, and facilitating interdisciplinary dialogue between engineers, architects, policymakers, and communities.

Stakeholders also suggested that the Transformation Lab (T-Lab) in Thimphu – built and established as part of the ReBuilt project – could act as a physical anchor for this platform, hosting workshops, exhibitions, and technical training while connecting local initiatives to regional and international networks on regenerative building. By institutionalising these knowledge exchanges in partnership with local institutions such as CST, Bhutan could create a continuously adaptive learning ecosystem that sustains innovation, policy coherence, and professional literacy across the construction sector.



Fig. 3.37 (left):
Employees of MoIT at a
ReBuilt stakeholder workshop
© Kéan Koschany, 2024



Fig. 3.38 (right):
Examination of a timber log at
a FMU in Bumthang
© Kéan Koschany, 2024

Education, Training, and Human Capacity Development

Especially critical gaps in technical skills and professional expertise were identified by local stakeholders, particularly in working with timber, bamboo, hemp, and earth materials. They emphasised the need to integrate regenerative construction principles across vocational, technical, and higher education curricula, ensuring that architects, engineers, and craftsmen are trained to handle nature-based materials safely and effectively.



Fig. 3.39:
Manual woodworking for a
temple reconstruction in
Lamai Lhakhang, Paro
© Bas Princen for Bauhaus
Earth, 2024

Evidence from an online survey conducted by the ReBuilt team in July 2024 supports these findings: a shortage of skilled labour was identified as the most pressing challenge within Bhutan's construction sector, cited by 89 of 106 respondents. The study also showed that more than half of professionals have limited familiarity with regenerative building principles, underscoring the urgency of education and upskilling efforts.⁸⁴

Several discussions linked this agenda to Bhutan's broader goal of green employment generation. Expanding regenerative construction training was seen not only as a means to build technical competency but also to create new livelihood opportunities and reduce dependency on foreign labour. Participants suggested establishing apprenticeships, certification schemes, and public-private training partnerships to professionalise regenerative construction as a viable and respected career path.

Labour Dynamics and the Construction Workforce

Bhutan's construction workforce has undergone profound changes in recent decades. Historically, construction was a communal process rooted in local craftsmanship and reciprocity: carpenters, masons, and artisans transmitted their knowledge through apprenticeship and collective house-building traditions, reinforcing social cohesion and preserving vernacular techniques.

^{85, 86}

⁸⁴ Arushi Gupta, Jamyang Penjore, and Georg Hubmann, "Perceptions of Nature-Based Materials in Bhutan's Construction Sector," (unpublished conference paper) (Sustainable Built Environment Conference, Zurich, 2025).

⁸⁵ Alexis Anne Bennett, "Tradition, Quality, Housing, Development: A New Paradigm for Urban Bhutan," Mit.edu (Masters Thesis, 2002), 33-36, [Link](#).

⁸⁶ Wangzom Dorji, "Traditional FarmHouse and Contemporary Dwellings of Bhutan - a Transformation," Journal of Urban and Landscape Planning 4 (December 18, 2019): 54-65, [Link](#).

In today's rapidly urbanising context, however, this locally embedded system has largely given way to a dependence on foreign labour. Around 85% of approved work permits in 2023 were issued for the construction sector, with roughly 90% of on-site workers being non-Bhutanese, predominantly from India.⁸⁷ This reliance reflects both the labour-intensive nature of modern construction and a declining interest among young Bhutanese to enter the trade. Despite high youth unemployment, many prefer public-sector or overseas employment due to better working conditions,⁸⁸ higher pay,⁸⁹ and greater social prestige.^{90, 91}



Fig. 3.40:
Migrant construction workers
in Thimphu
© Kéan Koschany, 2024

These structural imbalances have created a dual challenge: the domestic workforce remains underutilised, while the construction sector struggles with chronic dependency and skill shortages. Stakeholders repeatedly emphasised that shifting perceptions of construction work – currently associated with hardship, low status, and insecurity – is key to addressing this divide. Integrating regenerative construction principles into education and training, establishing visible role models and professional networks, and promoting public appreciation through outreach and demonstration projects can help reframe the sector as a source of green, safe, and meaningful employment.

Public Awareness and Regenerative Literacy

While the problem of limited awareness was widely acknowledged, workshop discussions focused on strategies to reframe perceptions rather than reiterate barriers. Participants called for multi-channel outreach initiatives – including public exhibitions, industry conferences, and national award programmes – to showcase Bhutanese frontrunners and celebrate successful regenerative projects. Communication efforts should highlight not only environmental benefits but also cultural and aesthetic values, demonstrating how regenerative design embodies Bhutan's identity and the ethos of Gross National Happiness.

⁸⁷ Jumana Alaref et al., "Bhutan Labor Market Assessment Report," 2024, 53, [Link](#).

⁸⁸ Kuensel, "Poor Occupational Health and Safety in the Construction Sector," Kuensel Online, June 16, 2021, [Link](#).

⁸⁹ Kuensel, "Youth Working in Construction Sector Not Paid on Time," Kuensel Online, November 3, 2021, [Link](#).

⁹⁰ Jumana Alaref et al., "Bhutan Labor Market Assessment Report," 2024, 28, [Link](#).

⁹¹ Roderick Wijunamai, "Migrant Construction Workers in Bhutan: Understanding Immigrant Flows and Their Perceptions," Rig Tshoel – Research Journal of the Royal Thimphu College 3, no. 1 (September 2020): 46–57, 50, [Link](#).

The ReBuilt survey further illuminates these dynamics: despite strong appreciation for the cultural compatibility and aesthetic appeal of nature-based materials, many professionals still associate them with higher maintenance requirements, fire-safety concerns, and limited suitability for large-scale buildings. Importantly, the study found that younger respondents prioritised environmental performance, while older respondents emphasised cost and tradition – revealing a generational shift in values that could be leveraged through targeted outreach and education. These insights reinforce the need for tailored awareness campaigns that build trust in technical performance while reconnecting regenerative construction to Bhutan's cultural identity.

Demonstration Projects and Learning Environments

Further, demonstration projects were seen as indispensable tools for learning, experimentation, and public engagement. Local stakeholders stated that demonstrators function as interactive learning environments – spaces where builders, students, policymakers, and communities can experience regenerative construction firsthand. These projects should be closely connected to training curricula and research activities to maximise their educational and policy relevance.

The research showed that demonstration and awareness initiatives are essential for overcoming regulatory and cultural barriers by providing tangible evidence of safety, durability, and cost performance. The newly established Transformation Lab in Thimphu was frequently mentioned as a potential hub for such activities – a platform for hands-on prototyping, interdisciplinary collaboration, and dissemination of findings.



Fig. 3.41:
Exhibition on regenerative
building practices and
local nature-based
construction materials at
the T-Lab in Thimphu
© Tino Imsirovic, 2024

Thematic Vision

Bhutan envisions a culturally grounded construction culture shaped by knowledge, creativity, and shared purpose. Regenerative design principles are embedded across education, training, and professional practice, empowering a new generation of builders, architects, and policymakers. The regenerative construction sector is guided by evidence, enriched by traditional wisdom, and valued by society. A vibrant domestic market for nature-based materials flourishes – supported by skilled professionals, informed consumers, and a shared awareness of how regenerative construction sustains both communities and local ecosystems.



Fig. 3.42:
Newly crafted timber elements for a temple reconstruction in Lamai Lhakhang, Paro
© Bas Princen for Bauhaus Earth, 2024

Overview of Actions

Regional Opportunity 5 focuses on cultivating the human, cultural, and institutional capacities needed to anchor Bhutan’s regenerative construction sector in its people and places. Its actions strengthen awareness, education, and collaboration across all levels. Deeply interlinked with the other roadmap areas, RO5 both builds on and enables progress across the wider system. It translates the enabling conditions established through nature-based material value chains (RO1), research and innovation (RO2), regulatory reform (RO3), and financial mobilisation (RO4) into human capability and cultural acceptance, fostering a skilled workforce, technical literacy, and broader societal awareness.

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1. Conduct Market Research on Demand and Perceptions of Nature-Based Materials

Timestamp

Short Term
(2030)

Scale



Building



National

Description:

Undertaking targeted market research is critical to understanding the drivers and barriers shaping the uptake of regenerative construction in Bhutan. Studies engaging communities, building professionals, and industry stakeholders will help identify existing traditional knowledge, knowledge gaps, and cultural perceptions regarding the use of nature-based materials such as timber, bamboo, earth, and hemp. The study frameworks will be based on participatory processes that include relevant stakeholders from the start to maximise audience participation and uptake. The results will also provide insight into the social acceptability of these materials, highlighting potential adoption barriers rooted in perceptions of durability, status, or cost.

In addition to cultural and perceptual dimensions, research will assess expected demand and the market potential of regenerative construction practices. By systematically mapping consumer preferences, industry readiness, and supply chain dynamics, these studies can inform both policy design and private investment strategies. Generating this evidence base will be essential for shaping awareness campaigns, training initiatives, and financial instruments that respond to real demand while addressing barriers, thereby anchoring regenerative construction within Bhutan's broader socio-economic and cultural landscape.

Key Intervention Fields:

- Building Practices and Culture
- Socio-Spatial Equity
- Collaborative Governance

Stakeholders:

- Department of Human Settlement
- Department of Infrastructure Development
- Department of Forests and Park Services
- Department of Environment and Climate Change
- College of Science and Technology
- College of Natural Resources
- Local Governments
- Existing Research Centres
- Professional Associations

Impact

- Generates evidence on cultural perceptions, consumer preferences, and industry readiness, guiding effective policy and investment decisions.
- Identifies adoption barriers early on, enabling tailored awareness campaigns and capacity-building programmes.
- Highlights opportunities to integrate traditional knowledge with modern construction practices, reinforcing cultural integrity.
- Provides a realistic assessment of demand, supporting the design of financial incentives and market-development strategies.
- Strengthens confidence among private-sector actors by clarifying market potential for regenerative construction.

Trade-offs

- Research and training programmes require sustained funding and expertise.
- Risk of data remaining underutilised if target audiences and their needs are not well understood or incorporated into study design.
- Findings may challenge entrenched practices or reveal resistance, requiring sensitive communication and engagement.

2. Integrate Regenerative Construction Principles into Education and Training Programs

Timestamp

Short Term
(2050)

Scale



National

Description:

Integrating regenerative construction principles into Bhutan's education and training system is essential for building the human capacities required for a sectoral transition. In its early stages, this action calls for a step-by-step revision of curricula across TVET institutions and universities to include regenerative building concepts and practices. This includes interdisciplinary learning modules that introduce students to regenerative thinking, nature-based materials, circular construction approaches, and climate-resilient design. At the TVET level, professional hands-on courses can train artisans and technicians in working with materials such as timber, bamboo, earth, and hemp, linking classroom learning to on-site construction practice.

Emphasis should eventually shift towards technical expertise and practical application. Within the RUB, programmes can integrate both the theory and practice of regenerative design and construction – combining architectural, engineering, and environmental perspectives to foster interdisciplinary literacy. At the high school level, project-based learning programmes can nurture environmental literacy and an appreciation for Bhutanese vernacular architecture from an early age. Such training will ensure that graduates across all education pathways are prepared to contribute to a carbon-neutral and culturally grounded built environment.

Key Intervention Fields:

- Building Practices and Culture
- Socio-Spatial Equity
- Capacity Strengthening

Stakeholders:

- Department of Human Settlement
- Department of Infrastructure Development
- Department of Forests and Park Services
- Department of Environment and Climate Change
- Department of Workforce Planning and Skills
- Bhutan Qualification and Professional Certification Authority
- College of Science and Technology
- College of Natural Resources
- Jigme Namgyel Engineering College
- TVET Centres

Impact

- Builds a new generation of skilled professionals and craftsmen trained in regenerative practices, ensuring long-term sectoral capacity.
- Strengthens environmental literacy and cultural appreciation among younger generations, linking climate action to Bhutanese identity.
- Encourages interdisciplinary collaboration by embedding regenerative thinking across technical, design, and social sciences curricula.
- Enhances employability by equipping graduates with practical skills in nature-based construction, aligned with emerging labour market needs.
- Creates stronger connections between education, industry, and research institutions, ensuring that training is relevant and demand-driven.

Trade-offs

- Curriculum reform and the development of new teaching materials are resource-intensive, requiring sustained funding and technical expertise.
- Mechanisms are needed to keep curricula up to date with evolving industry practices and research, which demands close coordination across institutions.
- Traditional assessment approaches may be inadequate; new standards and methods will be required to evaluate both theoretical knowledge and practical competencies.

3. Showcase High-Visibility Demonstration Projects of Regenerative Construction

Timestamp

Short Term
(2030)

Scale



Building



National

Description:

Constructing publicly accessible demonstration sites in prominent locations will provide tangible examples of regenerative building typologies and enable equitable access to regenerative spaces for communities. Strategically located in urban centres, cultural hubs, or high-traffic public areas, these sites will host awareness campaigns, workshops, and community programmes designed to inspire public appreciation and consumer demand. Promoted through tailored outreach programs, sites will act as living classrooms where students, artisans, professionals, and policymakers can directly experience the performance, aesthetics, and cultural relevance of nature-based construction.

Beyond their educational role, demonstration sites will function as inspirational platforms for replication. By incorporating locally available materials into well-designed structures, the demonstrators will highlight how regenerative construction supports both environmental sustainability and human wellbeing, building public trust and awareness. They will showcase how Bhutanese vernacular building practices – rooted in cultural heritage and local knowledge – can be integrated with modern regenerative thinking to meet contemporary performance standards. When paired with systematic monitoring and evaluation, the lessons generated will inform standards, curricula, and investment

Key Intervention Fields:

- Building Practices and Culture
- Socio-Spatial Equity
- Capacity Strengthening
- Material Transition

Stakeholders:

- Department of Human Settlement
- Department of Infrastructure Development
- National Housing Development Corporation Ltd
- Gelephu Mindfulness City Authority
- Construction Development Corporation
- Royal University of Bhutan
- Gyalsung Infra
- Local Governments
- TVET Centres
- Industry Actors
- Local Artisans and Builders
- Professional Associations

Impact

- Normalises regenerative practices and embeds them within Bhutan's architectural identity.
- Strengthens public legitimacy of regenerative construction through tangible built examples.
- Enhances capacity-building by integrating practical demonstrations into education, training, and professional development.
- Creates reference projects that support the development of new building codes, standards, and certification systems.
- Positions Bhutan regionally by offering examples that can be shared as models for knowledge exchange within the Himalayan region.

Trade-offs

- High upfront costs for design, construction, and maintenance.
- Risk of demonstrators remaining symbolic "showpieces" if they are not integrated into broader procurement and regulatory frameworks.
- Technical or performance failures would be highly visible and could undermine confidence in regenerative approaches.
- Long-term maintenance and programming require clear governance and sustained funding.

4. Connect and Amplify Frontrunners Championing Regenerative Construction

Timestamp

Medium Term
(2040)

Scale



Regional



National

Description:

This action seeks to cultivate a collaborative culture of innovation, learning, and recognition in Bhutan's transition towards regenerative construction by linking frontrunners across design, research, and building practice. Establishing national knowledge and exchange platforms – through forums, conferences, trade fairs, workshops, and digital networks – will bring together architects, engineers, researchers, builders, and policymakers to share proven solutions, document lessons learned, and co-develop new approaches that bridge vernacular wisdom with contemporary technologies.

To sustain momentum in the long term, these platforms should be embedded within a national collaboration framework that institutionalises spaces for dialogue and recognition while building on existing professional associations. Targeted outreach programs, competitions, and award programmes will highlight excellence in aesthetic quality, environmental performance, material innovation, and social inclusion. Cross-sector and cross-regional networks will help consolidate dispersed innovation efforts into a coordinated ecosystem. Over time, such networks can evolve into entrepreneurial and research clusters capable of piloting and scaling regenerative construction practices domestically, while also exporting Bhutanese expertise regionally.

Key Intervention Fields:

- Building Practices and Culture
- Collaborative Governance
- Capacity Strengthening

Stakeholders:

- Ministry of Infrastructure and Transport
- Ministry of Education and Skills Development
- Royal University of Bhutan
- TVET centres
- Existing research Centres
- Industry Actors
- Professional Associations
- Start-ups and Social Enterprises
- NGOs and Cultural Organisations
- Community-based Organisations

Impact

- Creates national visibility for pioneering actors, inspiring wider adoption of regenerative construction practices.
- Fosters peer-to-peer learning and collaboration across disciplines.
- Builds a culture of recognition that motivates practitioners and validates regenerative approaches as both modern and culturally grounded.
- Consolidates scattered initiatives into coordinated networks.
- Positions Bhutan as a regional knowledge hub by nurturing entrepreneurial clusters that can export expertise and solutions across South Asia.

Trade-offs

- Requires sustained funding and organisational capacity to maintain platforms, forums, and related initiatives.
- Potential overlap with existing professional associations or regional networks if coordination mechanisms are not clearly defined.
- Without alignment to policy and procurement frameworks, recognition platforms may remain symbolic rather than translate into systemic change.



Fig. 3.43:
Farmhouse near Punakha/
© Kéan Koschány, 2024

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A Collaborative Roadmap for the Transition to a Regenerative Built Environment in Thimphu-Paro

Shaping Bhutan's Regenerative Built Environment by Linking Local Material Resources, Enabling Regulatory Frameworks, and Regional Innovation

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