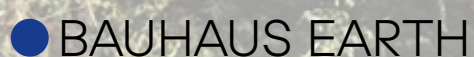


REGENERATIVE BHUTAN

a bio-material pathway
to healthy forests and
carbon positive cities

scoping mission report and project proposal



As a developing country, we have limited resources. We must manage our available resources wisely, minimize waste, and ensure that all our resources are directed at improving the well-being of the people, and in fulfilment of our national vision.

- His Majesty the King Jigme Khesar Namgyel Wangchuck

Construction is seen in so many countries as Dirty, Dull, and Dangerous. For a Construction Industry to be truly sustainable, it needs to be “cool” to attract young people. “Cool” = Technological, Creative, and Rewarding.

This means Maximising the use of technology and digitization to plan, design, and manufacture.

Maximising factory- and office-based jobs that are safe, comfortable, and conveniently located.

Minimising site time and congestion; adopting resilient and efficient planning.

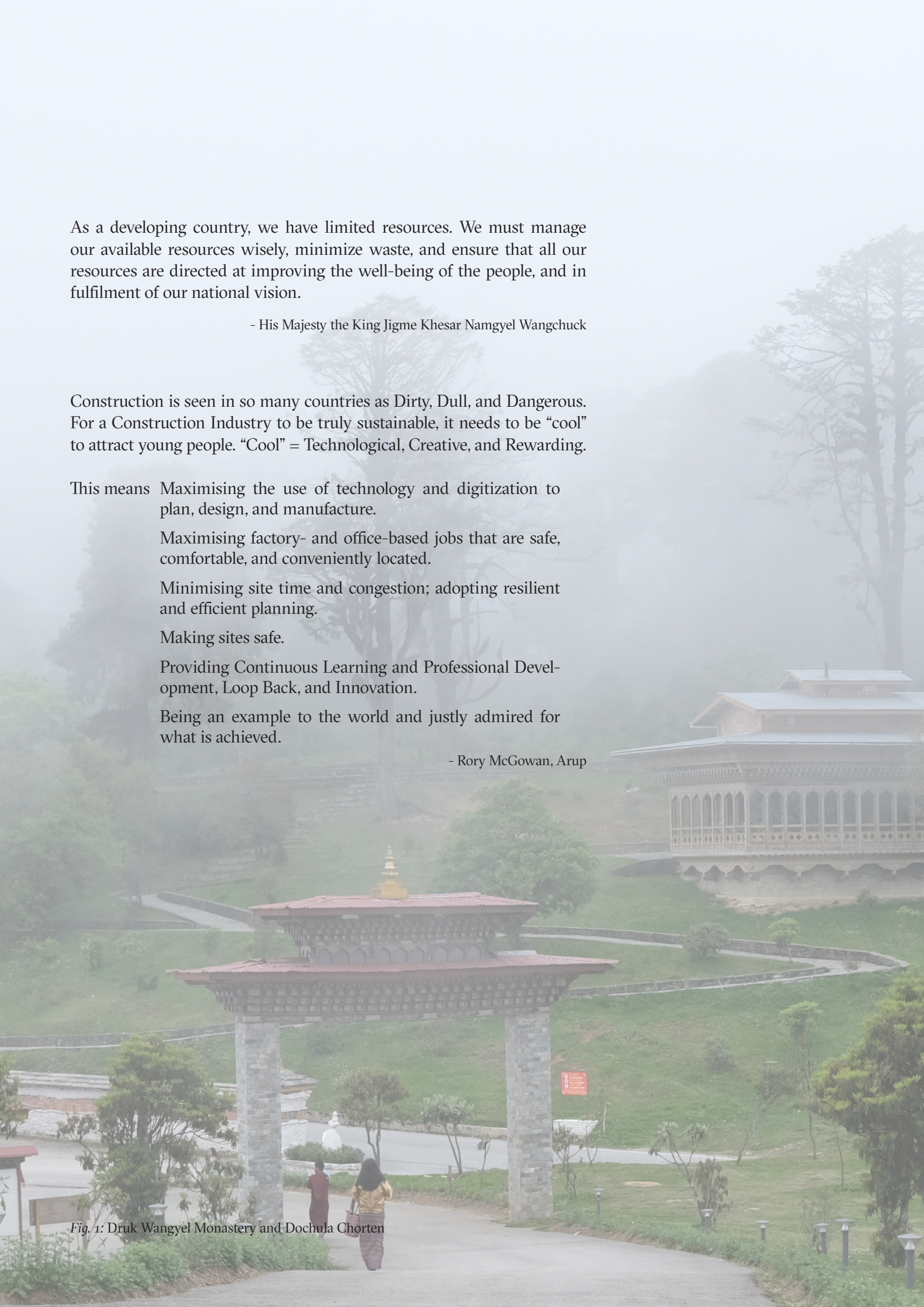
Making sites safe.

Providing Continuous Learning and Professional Development, Loop Back, and Innovation.

Being an example to the world and justly admired for what is achieved.

- Rory McGowan, Arup

Fig. 1: Druk Wangyel Monastery and Dochula Chorten





Within the context of a nation experiencing exponential economic and population growth, the amount of forest cover in Bhutan is remarkable if not miraculous. These levels have not been maintained by chance but rather by a view of forests as a sacred cultural heritage and a legacy of a proud kingdom. They are kept standing due to the wisdom of a Royal Decree. The government agencies are their stewards and local communities their guardians. These same principles of respect for Bhutan's forests must surely also be applied to what comes out of the forest!

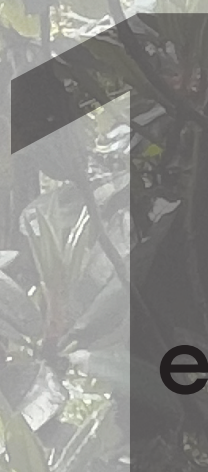
Instead of telling the forest what we want, we need to ask the forest what it can sustainably offer us.

- Jamie Lawrence

A theory of change? Only through the systemic transformation of the building lifecycle—the sources, materials, means, and methods of urban buildings; their utility, durability, and beauty; and ultimately the protection of that material and energy investment over many future, long-lasting lifecycles — can we hope to restore the kinds of upstream environmental health and stability while creating downstream social well-being and security that will be critical to the survival of our own species and the species who dwell with us on this planet. The path to a truly regenerative city runs through (and back into) the forest.

- Alan Organschi, Bauhaus Earth





executive summary

a trail through the forest...

Executive Summary

a trail through the Forest...

The Kingdom of Bhutan, under the leadership of His Majesty King Jigme Khesar Namgyel Wangchuck, has called for the sustainable transformation of his country's urban construction sector. The steady urbanization of the Thimphu Paro Capital region and its growing demand for housing and infrastructure has threatened both the natural ecosystems and national cultural heritage of its local landscapes. The sector's current reliance on extractive, mineral-based, and energy- and emissions-intensive building materials, means, and methods, on poorly performing urban construction assemblies and structural/architectural typologies, and on outsourced construction labour, management, and finance by non-Bhutanese building developers and workforces, has made Bhutanese city building both unaffordable and unsustainable. If such practices continue, the building sector will be unable to meet demand nor provide for the health, well-being, and livelihood of its urban citizenry, while contributing only marginally to the country's domestic economy. Moreover, the continuing operation and maintenance of building stock produced today will create ongoing technical and financial burdens only to serve as stranded assets in the foreseeable future.

Although Bhutan's abundant forest cover and constitutionally mandated forest protections serve to make this small country a global model of national carbon neutrality, the Bhutanese construction sector creates a significant counterforce to the country's perceived environmental health, its measurement of "gross national happiness" and His Majesty's vision for a deeply sustainable society.

To align building design and construction practice with that vision and to promote potential synergies between regenerative forestry, a robust building economy with minimal ecological impact, and the healthy growth and management of the country's cityscapes, Bhutan's Ministry of Works and Human Settlement convened in May of 2022 a working group comprised of both government representatives and visiting experts from forestry, industry, city planning, engineering and architecture. Their mandate was an assessment of the feasibility of building sector transformation and development of an implementation strategy that would remap the building supply chain and reshape construction practice. Although mass timber material systems and techniques and the potential environmental benefits that might accrue from their adoption was to serve as the primary focus of the scoping and strategy mission, the potential development of other bio-based construction materials and products and, more broadly, a domestic circular construction economy, were also to be considered. The result of the two-and-a-half week series of presentations, workshops, and study trips, was an interdisciplinary, system-wide analysis with topics that ranged from the makeup and condition of forest sources, through silvicultural methods and practices, material processing and product manufacturing, construction delivery and building regulation, and ultimately to the healthy inhabitation and sustainable operation of high performance urban building in Thimphu and urbanized settlements throughout Bhutan.

This report summarizes the findings and outlines the recommendations of that working group and its scoping mission. It is divided into two primary sections:

- * a report of those findings which describes current contexts and offers a set of baseline conditions from which to launch a systemic overhaul of urban construction and the buildings it produces to dramatically improve material, structural, and environmental performance and enhance economic vitality and social benefit.
- * a proposed set of recommendations for next steps in that transformation that include immediate actions to be undertaken in tandem with a series of pilot projects designed to address and engage specific aspects of urban building demand, the sequential stages of Bhutan's system of building supply, and the workforces and skillsets required to effect such a transition. These pilot projects will, in turn, offer platforms for the development and deployment of critical skills and good practices, the dissemination of knowledge and the encouragement of public consensus, the refocusing of forestry and the retooling of industry, and the ongoing assessment and rebalancing of environmental impact with eco-systemic benefit.



2

scoping mission report

Approach

The Scoping Mission was designed as an inter- and transdisciplinary co-creative process that brought together international guests and key Bhutanese stakeholders from ministries, industries, and university to co-produce knowledge and ideas for the transformation of Bhutan's construction sector. The international team acted as advisors or supporters in the process by identifying and networking relevant stakeholders, facilitating and structuring learning and knowledge flows, and broadening perspectives beyond the Bhutanese context by sharing international good practices and latest research.



Fig. 8: Workshop Exchange

The workshops, conceived and designed to facilitate the co-development of strategies for the systemic transformation of the building sector were organized around critical stages of the building lifecycle and rooted in the sustainable management of the forests that would supply it.

1. **Source and Supply:** the current health, makeup, and range of Bhutanese forests, their governance and the protections and management practices applied to them, their productive capacity in sustainably supplying a domestic building industry with potentially growing urban demand, and their attention to ecological health and biodiversity.
2. **Material Processing and Product Manufacture:** current capacities, practices, and levels of efficiency in the processing of timber and the manufacturing of secondary wood products with building sector application; material handling and transport from source to building site, logistical limitations with respect to infrastructure, equipment and mechanization, the forest workforce, and waste management and reuse; non-biobased renewable material innovations as additional alternatives to conventional building material use.
3. **Design, Construction, and Regulatory Oversight:** current concerns and approaches of urban planning and building design; the construction process, its techniques, its workforce and management, and its contractual framework; building regulations, their enforcement and their effectiveness at implementing the country's sustainability vision and safeguarding building quality, performance and life-safety; the potential of off-site manufacturing, design-for-disassembly and material and component reuse with respect to long-term sustainability and impact reduction.
4. **Whole-building Systematization, Scaling, and Replication:** considerations regarding the implementation of new whole-building systems with new environmental performance criteria, construction techniques, products and assemblies, and urban building typologies and broad deployment within current and developing urban planning and industrial policy frameworks; the promotion of interdisciplinary, trans-sectoral partnerships and processes.

Objectives and Expectations

The objectives of the scoping mission were defined as follows:

- “ facilitate learning and knowledge exchange;
- “ clarify and take stock of current practices, policies, knowledge gaps and institutional barriers and to identify potential opportunities and levers for systemic change;
- “ collect available datasets, identify existing knowledge bases and skill sets, assess systemic gaps and strategize specific and immediately applicable means of capacity-building;
- “ conduct initial fact-finding tours of relevant forests, manufacturing, and urban project sites;
- “ identify potential project partners across the Bhutanese forest, building, educational, and administrative sectors;
- “ develop an implementation framework and scope including the clarification of potential demonstration project(s), their use-program(s) and implementation site(s).

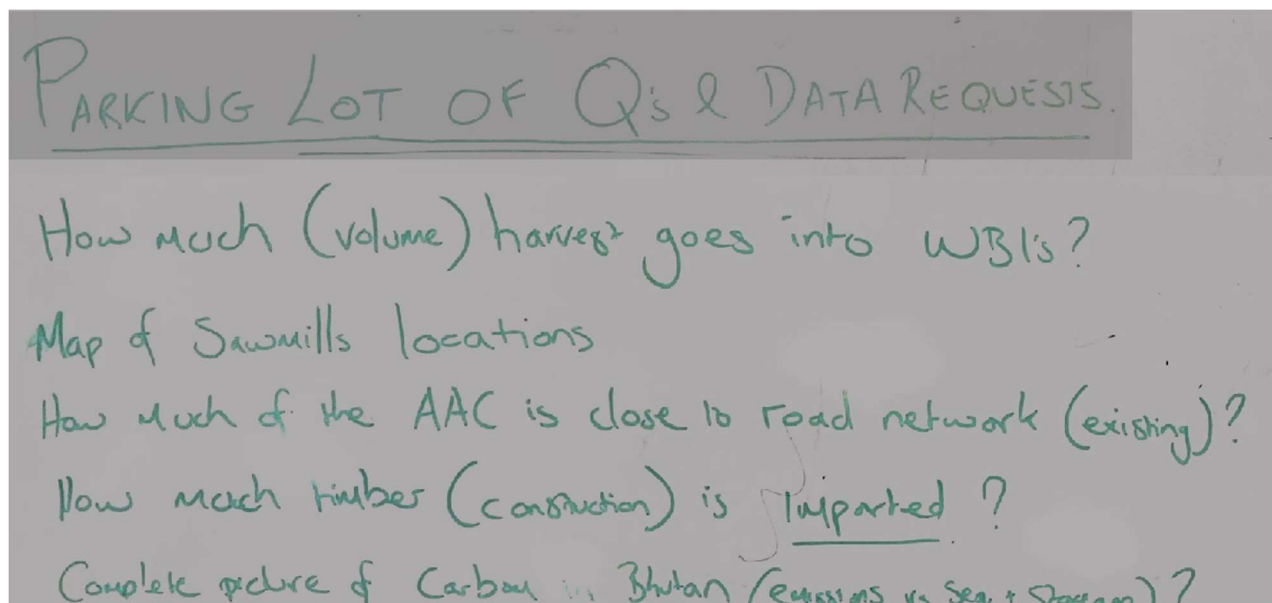


Fig. 9: Workshop Requests for Information

Over the course of 5 days of workshops, with the combination of formal presentations of policy, practice, and data by experts and subsequent discussion and collaboration among participants, a set of fundamental expectations took shape concerning the opportunities (as well as pitfalls) of the transformation process itself, above and beyond a set of experimental results or physical deliverables. These process-based expectations were summarized as follows:

- “ change mindsets and perceptions towards the use of timber and other bio-based materials as a new and demonstrably sustainable language of construction;
- “ develop a system-change-approach for the construction sector;
- “ create a policy environment that demonstrates the value of transitioning to a bio-based construction industry that serves Bhutanese society and can become a model to the world;
- “ forge a strong network of partners who share the same vision and drive to deliver action through cross-agency and interdisciplinary collaboration;
- “ identify and implement pragmatic, practical next steps in a roadmap of activities that are replicable and widely deployable;
- “ upskill Bhutanese workforce knowledge, building on existing assets, skills and expertise;
- “ create an industry and building typology which is specific and relevant to Bhutan by developing a model with processes and technologies that are unique to its resources, people, and culture;
- “ develop a portfolio of wood-based, systematized building components to promote off-site manufacture and rapid building assembly and thereby capture the interrelated benefits of increased speed, improved organization, and economic and material efficiency.
- “ make the construction industry cool and exciting to overcome its negative reputation, optics, and associations



3

project proposal

Principles and Pilot Projects in Regenerative Construction

Learning by Making

By the conclusion of the scoping mission, participants had reached consensus that the most effective means to explore, test, and model a transition from business-as-usual construction practices—with their deleterious combination of negative impact, poor outcomes, and significant cost—was to build the alternative: a building or series of buildings that could serve as fully functional testbeds of innovative buildings solutions, as demonstrations of feasibility and a proof of the value of the regenerative building concept. These “breakthrough” projects would be conceived and developed by Bhutanese design and engineering professionals, sited in prominent and publicly accessible urban sites in Thimphu or other Bhutanese cities, constructed using innovative materials and systems developed and manufactured by Bhutanese industry and assembled by Bhutanese construction workers under Bhutanese management. Those innovative materials would be drawn from sustainably Bhutanese forests or other biological sources or, where feasible, remanufactured using circular economic principles and practices that would utilize reused or upcycled residues from Bhutan’s consumer, construction, or industrial waste streams. As initially requested by the Department of Human Settlement at MoW- HS, the ‘Regenerative Construction Industry’ project will focus primarily on bio-based materials - especially timber - but would also address the role and relevance of other currently prevalent materials such as concrete and steel or the potential of non-domestically produced bio-based products as transitional solutions during the transformation process.



Fig. 19: Student design build off site manufacturing activity

Process as Goal

A consideration deemed critical by workshop participants was that development of the process must have comprehensive and systemic import, and that the robust collaboration and interdisciplinary, participatory conduct of the process was as significant a measure of success as the quality of the building that it would produce. That process would serve as a means to translate research and experimentation into practice, and the observations and findings of the scoping mission (Part 1) into a framework and pathway for the systemic overhaul of Bhutan's construction sector. The project seeks to address the desire for rapid and tangible change by defining clear actions implementable in the short term, while setting the course for a long and deep transformation process.

To support system-wide shifts in behaviour and practice, pilot projects can serve not only as valuable testbeds and effective tools of knowledge creation and transfer, but can also build consensus by offering a glimpse (and even the experience) of an alternative future. Full scale, tangible demonstrations of new processes and outcomes, capable of unlocking the full climate

potential of forests and cities working in sympathy and synergy; and of sustainable forest-based materials and products and other low-carbon building elements coordinated to produce replicable, high quality, high-performance buildings, and spaces. All these attributes are powerful catalysts for cultural change and technical advancement. Their actualization through pilot projects must be accompanied by strategic efforts in scientific and technical research, fortified by process experimentation, testing, and rehearsal, and informed by stakeholder outreach feed-back and the full support and engagement of industry in order to inform approaches, build reliable knowledge and meaningful capacity, and deliver transformative action. Accordingly, the pilot project scope is built upon two primary elements: 1) Workstreams focused on strategic research, capacity building, outreach, and industry engagement, and 2) the realization of designated pilot projects.

Vision and Objectives

The overarching vision of the project is to build a ‘framework for change’, a conceptual but realizable armature for the system-wide transformation of Bhutan’s urban building material and practice with the goal of restoring and upstream environmental health and ensuring downstream social well-being.

The immediate project goals arising from that vision are threefold:

1. Support the development and implementation of prototypical demonstration projects using engineered timber components from species native to Bhutan’s forests as well as other bio-based and circular economic materials to:
 - * make systemic change tangible and widely visible
 - * send a signal to the market and provide a stimulant to industry
 - * create consumer/stakeholder buy-in and build social licence through continuous and broad engagement
 - * create a system wide proof of concept,
 - * respond to real need at appropriate scales,
 - * allow for process driven investigation and learning,
 - * build knowledge and capacity
 - * seek dramatic and measurable improvements in technical performance and human experience
 - * create a new system that properly measures previously unmonetizable values such as environmental impact mitigation, carbon storage, biodiversity enhancement, social inclusivity ...
 - * invent a new Bhutanese architecture (design, engineering, urban space-making) that integrates modern and traditional techniques and approaches
 - * demonstrate that construction offers dignified, rewarding, and exciting employment opportunity
 - * focus on solutions that are replicable and scalable
 - * over time, develop products as well as capacities as both expertise and commodities for export
2. Embed the demonstration projects into a strategic research, knowledge, capacity building and stakeholder engagement program to inform the design of the demonstrators and to generate impact beyond the physical building artefact
3. Identify pathways for the long-term transformation of Bhutan’s construction sector based on the outcomes of the demonstration projects and the accompanying program.



Fig. 20: Mass timber test assembly, Yale Regenerative Building Lab



Proposed Pilot for Immediate Implementation

During the course of the scoping mission and workshops, participants identified eight potential urban building types and infrastructural elements deemed of particular relevance and suitability as replicable proto-types for Thimphu and the demonstration of regenerative building value chains and techniques.

The following three building types were identified as high impact demonstrators of systemic transformation and are proposed here for immediate implementation:

1. Mixed use residential/commercial (potential ground floor sustainability R+D center with publicly-accessible model apartment unit and short term housing for Dessups program to be sited in a prominent location along on Norzin Lam)
2. Urban retrofit and environmental upgrade of existing hotel or housing on a site more peripheral to Thimphu's center
3. Affordable urban housing as replicable prototype urban settlement (Semtokha housing development site)

Additional building types were identified as reflecting specific need with- in the Thimphu / Paro region and their amenability to timber, bio-based, and other low-carbon material assemblies and recommended as future (primarily urban) testbed / demonstrators:

4. Bhutan baccalaureate school (addition to existing capacity or new prototype)
5. Contemporary office building
6. Urban furnishings (as ongoing student design-build projects)
7. Bridges (pedestrian)
8. Rural workforce housing

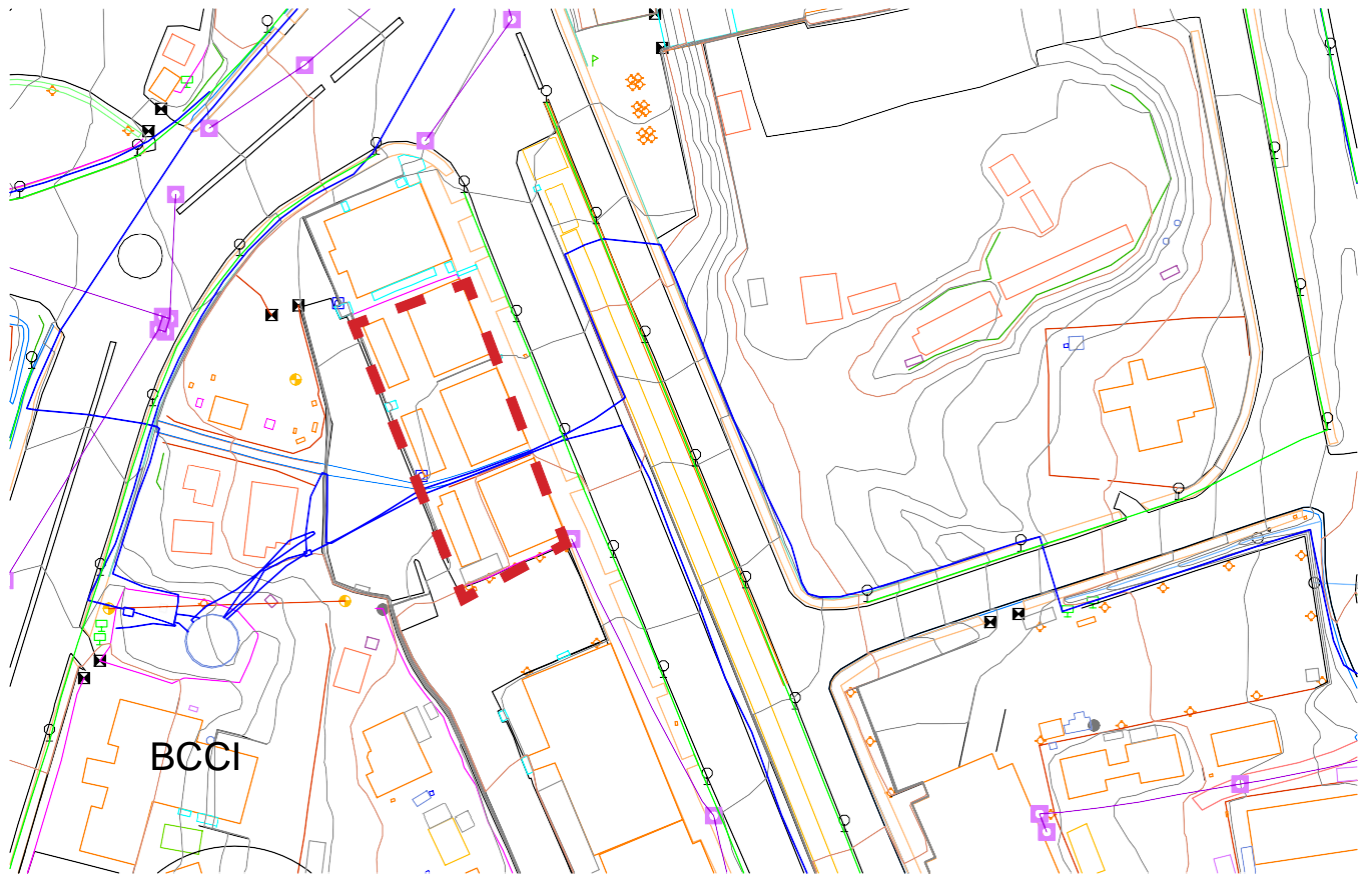
It was agreed that the initial programme of work should focus on the development and delivery sequence of the building types 1-3 to be sited, programmed, designed, and constructed roughly in parallel but with sequential dates of inception, reflecting differences in project externalities that might include funding, regulatory approvals, site availability, etc. It was felt by participants.

These occupancies were prioritized for their ability to meet a critical sequence of objectives:

- “ to produce high profile and publicly accessible demonstrations (project 1),
- “ to demonstrate approaches to the retrofit of existing, poorly performing building stock that characterizes Thimphu's recent development (project 2),
- “ to address the critical need for affordable urban housing (project 3).

The latter goal—the reflection of (and a solution to) pressing need—was considered to be a gateway criterion for any relevant “breakthrough” pilot project program and location.

Fig. 21: Possible site along Norzin Lam





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