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Best Practices in Building Systems (BPiBS): Advancing Knowledge Mobilization through Road Mapping

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ABSTRACT: The Best Practices in Building Systems (BPiBS) initiative seeks to drive much-needed change in the housing sector and building industry by addressing pressing technical, economic, environmental, social and health challenges. Through collaborative research and stakeholder engagement, BPiBS is developing an iterative roadmap to enhance building systems for new and existing housing across urban and rural Canada, beginning in British Columbia and informing national solutions.

This paper outlines the project's vision, focus areas, and early progress. Thematic research includes energy systems, building exteriors and grounds, health-centric design, water and waste systems, and building forms and structures.

Guided by the objectives of economic value, environmental sustainability, health and wellbeing, social equity, and innovation, BPiBS advances evolving, context-responsive best practices. These approaches are shaped by continuous learning across technical, ecological, economic, and social domains. They balance scalability with specificity, aiming for long-term well-being while addressing short-term needs.

Key activities include stakeholder engagement, a structured knowledge repository, use of AI and machine learning for interdisciplinary data analysis, scenario planning, and formulation of a roadmap and strategy for knowledge mobilization and capacity-building.

A graph database underpins the computational platform, organizing data into a living roadmap informed by input from policy actors, industry leaders, and educators. By enhancing alignment across industry, regulatory and education spheres, this project streamlines decision-making and accelerates adoption of emergent best practices within building systems. These systems are integrated networks of structural, infrastructural, and socio-environmental elements that support the function, adaptation, and livability of built environments. In housing, they co-create the places we call home.

1. INTRODUCTION

1.1 BPiBS Overview

Canada's housing crisis has prompted an urgent push to increase housing supply—but doing so adequately requires more than accelerated construction. A strategic, coordinated approach is necessary to align

stakeholders across the housing ecosystem towards collaborative solutions. This will help identify system-wide challenges, address emerging needs, and create the conditions needed to deliver housing solutions for Canada's future. The *Best Practices in Building Systems* (BPiBS) initiative responds to this need through a collaborative research effort focused on cross-sectoral alignment to identify pathways toward sustainable, dignified, and resilient housing outcomes. The initiative aims to accelerate collaboration across the housing sector by supporting the rapid adoption of best practices through the co-creation of a roadmap—a shared tool that enables stakeholders to establish common goals, coordinate actions, and implement scalable solutions for delivering future-ready housing across Canada. Best practices are not fixed templates, but evolving approaches shaped by context and continuous learning across technical, ecological, economic, and social domains. They balance scalability with specificity and aim for long-term wellbeing while addressing short-term needs.

In a partnership between BC Housing, the University of Victoria, Housing, Infrastructure and Communities Canada, BC Hydro, and Technical Safety BC, BPiBS brings together stakeholders from across the housing system and building sector to identify critical economic, technical, environmental, social, and health-related barriers to building adequate, high-performing housing. The roadmap will be designed to outline practical, actionable pathways for actors across the housing ecosystem to create housing solutions through new construction initiatives and retrofit applications in both urban and rural contexts. The roadmap will include a structured database of best practices, case studies, innovation strategies, and implementation recommendations. Co-created through interdisciplinary research and extensive stakeholder collaboration, the roadmap will be designed to evolve alongside the sector, providing a structured approach to achieving housing system innovation and long-term impact. While the project's initial focus will be on British Columbia, the framework is intended for national scalability and applicability.

This paper introduces the BPiBS project's context, objectives, methodology, and anticipated outputs, with the aim of supporting cross-sector alignment through the co-creation of tools, insights, and strategies to drive system-wide improvements and enable housing solutions that respond to the evolving needs of people and communities across Canada.

1.2 Context and Rationale

Canada's housing sector is at a pivotal moment, facing a complex set of interconnected challenges spanning economic, technical, environmental, social, and health dimensions. Addressing these issues requires a coordinated, systems-level approach that redefines how housing is designed, developed, maintained and governed. The following challenge areas form the foundation to identify the key barriers currently limiting progress toward sustainable, resilient, and inclusive housing solutions in Canada.

1.2.1 Economic Challenges

At the heart of the current crisis is a widening affordability gap. The Canada Mortgage and Housing Corporation (CMHC) estimates that 3.5 million new homes will be needed by 2030 to restore affordability, yet labour shortages, regional demographic shifts, and economic uncertainty are significantly constraining housing sector productivity (CMHC 2023). These economic constraints are compounded by systemic issues such as restrictive zoning policies and limited public investment in affordable housing, which further impede the delivery of new units (Zhang 2024a; Petterson et al. 2017). As a result, many developers struggle to bring projects to completion, while vulnerable populations face increasing rent costs and limited access to stable housing.

1.2.2 Technical Challenges

Canada's building industry faces critical challenges in modernizing construction methods to better align with today's climate demands and long-term sustainability objectives. Current practices often fall short in

providing the adaptability and innovation needed to respond effectively to increasing climate variability, extreme weather, shifting demographics, and evolving household needs (Liyanage et al. 2024). Furthermore, the integration of new technologies—such as low-carbon materials, prefabrication, and advanced energy systems—remains limited due to fragmented standards, insufficient training, and uneven regulatory uptake (Firoozi et al. 2025). These technical limitations hinder progress toward modern, high-performance, and resilient housing stock.

1.2.3 Environmental Challenges

The building sector is a major contributor to Canada's greenhouse gas emissions, accounting for 18% of the national total—making it the third-largest emitting sector (Natural Resources Canada 2022). Without a rapid shift toward low-carbon, circular, and regenerative building practices, the sector will continue to undermine national climate goals. Current construction and operational practices result in high embodied and operational carbon, waste generation, and biodiversity loss. Climate adaptation is also a growing concern, as many existing homes are ill-equipped to withstand heatwaves, flooding, wildfires, and other extreme events that are becoming more frequent across the country (Government of Canada 2022).

1.2.4 Social Challenges

Social inequities are being exacerbated by the housing crisis. Low-income households, newcomers, Indigenous communities, and people with disabilities face disproportionate barriers to accessing safe, affordable, and adequate housing (Zhang 2024b). Canada's National Housing Strategy has been criticized for lacking the scale and integration needed to drive systemic change (Varone 2025). Long waitlists for social housing, lack of culturally relevant design, and policies that fail to address structural inequities contribute to housing insecurity and displacement—particularly in urban centres experiencing rapid growth and gentrification (CMHC 2024).

1.2.5 Health and Wellbeing Challenges

Housing conditions are increasingly recognized as a determinant of health (Hu & Hasdell 2024). Inadequate ventilation, substandard construction, and limited access to nature or communal space can contribute to physical and mental health issues, particularly for seniors, individuals, children, and marginalized groups (Anyanwu & Beyer 2024). Rising costs have also led to overcrowding and housing precarity, both of which are linked to increased stress, illness, and reduced quality of life (Mental Health Commission of Canada 2023). As the climate continues to shift, the importance of health-informed, biophilic, and inclusive design becomes even more urgent for ensuring resilient and livable communities (Andreucci et al. 2021).

Canada's housing challenges present a strategic opportunity for industry professionals to co-develop scalable, future-ready solutions through the development of roadmap pathways. BPiBS provides the structured platform to align technical expertise and stakeholder experience across the sector to coordinate practical implementation strategies and drive action to address affordability, climate resilience, and construction barriers across the sector.

1.3 Vision, Mission, Goals, and Objectives

The following sections outline the strategic vision, mission, goals, and objectives guiding the BPiBS project. Figure 1 provides a framework of the timeline and current initiative relative to the overall project plan and vision.

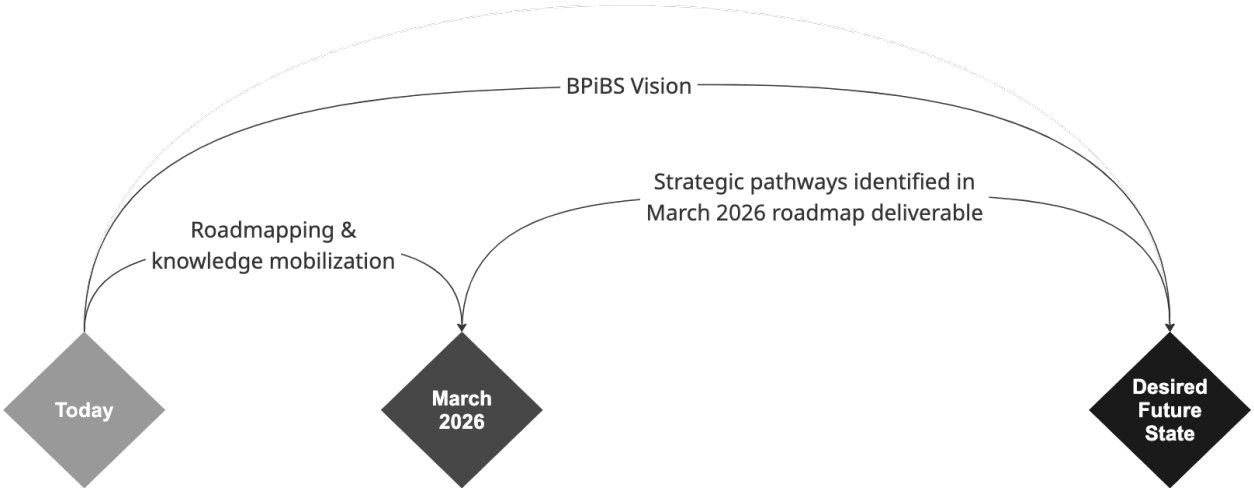

Figure 1: BPiBS project vision and timeline

1.3.1 Vision

A Canada where housing is approached as a shared responsibility that guides the creation of inclusive, sustainable, and resilient built environments, responding to the evolving needs of people, communities, and the ecological and economic systems they are part of.

1.3.2 Mission

To co-create a dynamic, systems-informed roadmap that aligns industry, regulation, and education through participatory collaboration, digital infrastructure, and knowledge mobilization to accelerate the adoption of best practices and deliver inclusive, sustainable, and resilient housing solutions across Canada.

1.3.3 Goals and Objectives

Goal 1: Foster cross-sector alignment across industry, regulatory, and education spheres to identify system-wide challenges and emerging needs.

- Objective 1a: Facilitate sustained stakeholder engagement to identify challenges, priorities, and opportunities for quick adoption of best practices.

Goal 2: Identify pathways to enable the rapid adoption of best practices across the building system.

- Objective 2a: Co-create a dynamic, adaptable roadmap organized around key building system themes, using methods from systems thinking, participatory design, strategic foresight.
- Objective 2b: Facilitate stakeholder collaboration to design actionable pathways to guide coordinated short-term actions and long-term system change.

Goal 3: Mobilize research findings to enable practical implementation, capacity-building, and regulatory integration across the housing ecosystem.

- Objective 3a: Develop a structured and scalable digital knowledge repository to support the collection, organization, integration, and retrieval of extensive knowledge assets to support the roadmap development.
- Objective 3b: Integrate Artificial Intelligence (AI) and Machine Learning (ML) tools to enhance data analysis and support roadmap development.

- Objective 3c: Translate research findings into accessible, actionable formats that support adoption, professional training, and system-wide impact.

Together, these goals and objectives form the basis for a structured approach to rethinking how housing is imagined, developed, maintained, and governed.

2. STRUCTURED APPROACH

2.1 Methodology

A structured methodology has been developed for BPiBS, following the Input-Process-Output (IPO) model, and grounded in systems thinking, participatory design, and strategic foresight. The research and development processes are organized into four iterative and interconnected phases: Context, Listening, Mapping, and Co-Designing. Each phase is designed to meet defined project objectives and is supported by continuous stakeholder engagement, reflexive practice, and integration with a digital knowledge infrastructure. This methodology will underpin the development of the roadmap. A visual representative of the IPO model is shown in Figure 2.

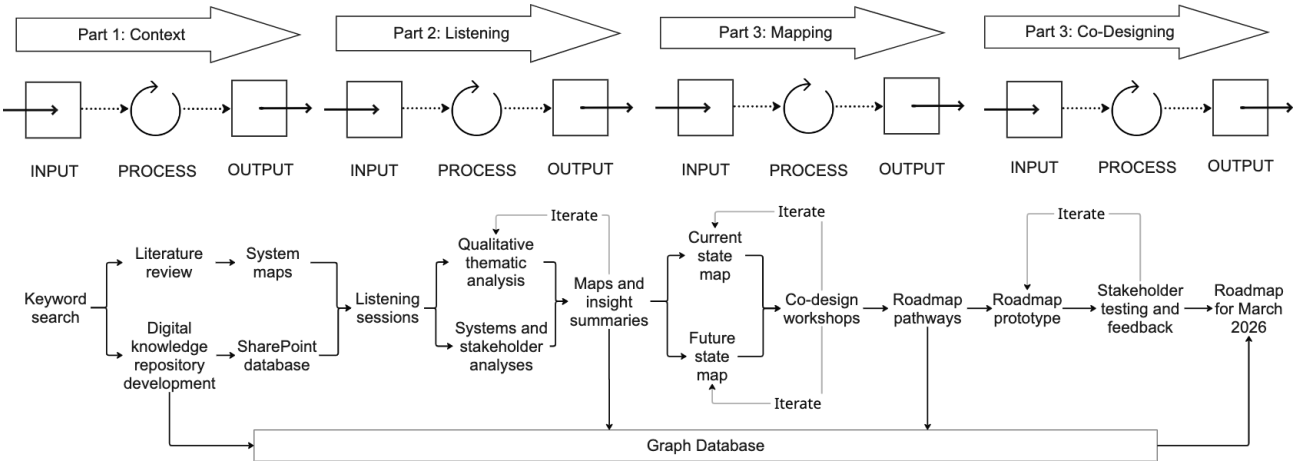

Figure 2: BPiBS project methodology using an IPO model

The following paragraphs detail the processes through each phase in achieving project objectives:

Phase One: Context – Scoping and Systems Foundations
Phase One will establish a foundational understanding of Canada's housing and building systems through a structured review of regulatory frameworks, construction practices, emerging technologies, and sector-specific challenges. This scoping process will identify key system constraints and opportunities to inform subsequent phases of the project. Systems thinking tools, such as stakeholder mapping and context analysis, will be applied to examine interdependencies across regulatory, industry, and education domains. A digital knowledge repository in the form of a graph database will be developed to consolidate and organize information. This infrastructure will support knowledge integration and long-term scalability. In parallel, Artificial Intelligence (AI) and Machine Learning (ML) capabilities will be explored to enhance data analysis and support roadmap iteration over time. This phase will lay the analytical and structural groundwork for roadmap development, ensuring that future activities are informed by a comprehensive, systems-level understanding of the housing ecosystem. Phase One will achieve project objectives 3a and 3b.

Phase Two: Listening – Stakeholder Perspectives and Priorities
In Phase Two, the research team will conduct virtual listening sessions with stakeholders and industry professionals to identify key priorities, challenges, and opportunities within the housing system. Each two-hour session will involve six to eight participants and be guided by open-ended prompting questions to support focused dialogue and collaborative exchange. Transcripts will undergo thematic analysis using both manual and AI-assisted methods. Insights will be iteratively mapped using systems tools, and key findings will be integrated into the graph database to inform the development of the roadmap. This phase will contribute directly to Project Objective 1a.

Phase Three: Mapping – Synthesizing and Visualizing the System
Phase Three will synthesize findings from Phases One and Two to develop a preliminary systems map and a draft Three Horizons framework (Sharpe 2020). Using thematic clustering and systems mapping tools, the project team will analyze interdependencies, constraints, and leverage points within current building systems, establishing a shared understanding of Horizon 1 (H1)—the current system state. Stakeholder insights will also be used to articulate long-term aspirations and desirable future conditions for the housing sector, forming the basis for Horizon 3 (H3). This dual focus will provide the structural and conceptual foundation for subsequent pathway development. Reflexive thematic analysis will support transparency and validation, while insights will be integrated into the digital knowledge repository. Phase Three will contribute directly to Project Objective 2a.

Phase Four: Co-Designing – Structured Roadmap Development and Knowledge Mobilization
Building on the Horizon 1 and Horizon 3 framework developed in Phase Three, Phase Four will focus on identifying and co-developing Horizon 2 (H2)—the transitional strategies and innovations needed to move from current conditions to desired future states. Stakeholders will engage in a series of co-design workshops incorporating scenario development and participatory foresight to explore system uncertainties, test assumptions, and design adaptive strategies. Horizon 2 will be shaped through collaborative identification of near- to mid-term interventions, policy levers, and implementation pathways. The output of this phase will be the first complete iteration of the BPiBS roadmap, which will be reviewed and refined through feedback sessions to ensure practicality, alignment, and sector relevance. In parallel, knowledge mobilization activities will disseminate findings through workshops, engagement events, discussion papers, and broad distribution of roadmap tools. Phase Four will address Project Objectives 2b and 3c.

2.2 Implementation Strategy

2.2.1 Team Structure and Role Definition

Following the establishment of project partnerships, the BPiBS steering committee conducted a targeted needs assessment to assemble a multidisciplinary core team aligned with the initiative's strategic objectives. Key roles were defined to address distinct project requirements including systems design, regulatory alignment, stakeholder engagement, and digital infrastructure. The following roles have been developed:

- The Strategic Outcomes Lead is responsible for overall project coordination, partnership development, and ensuring alignment with policy and regulatory frameworks.
- The Futures Impact Designer leads stakeholder engagement, co-design processes, and foresight initiatives to ensure participatory and future-oriented approaches.
- The Digital Innovation Specialist is focused on the development and management of the project's graph-based knowledge repository, including the integration of AI-powered tools to support data analysis and insight generation.
- The Technical Researcher is tasked with conducting comprehensive literature reviews, identifying emerging technologies, and analyzing systemic barriers and opportunities for innovation within the housing sector.

To support team cohesion and shared understanding, an internal workshop was held in March 2025. This session established a common mission, clarified working principles, and laid the foundation for ongoing interdisciplinary collaboration throughout the project lifecycle.

2.2.2 Stakeholder Engagement and Collaboration

Stakeholder engagement is a core implementation strategy within BPiBS, guided by principles of participatory design and systems thinking. The project prioritizes early and ongoing involvement of stakeholders mapped through Phase 1 and spanning across industry, regulatory, education, and community spheres to ensure solutions are contextually relevant, equitable, and scalable. Initial listening sessions will establish trust and surface priorities, while continuous feedback loops support iterative refinement of project outputs. This adaptive engagement model fosters shared ownership, improves the quality of decision-making, and strengthens the roadmap's practical relevance across diverse housing contexts.

2.2.3 Digital Knowledge Infrastructure

To support the work on a dynamic and evolving roadmap, BPiBS is developing a digital knowledge repository grounded in a Neo4j-based graph database. This repository is designed to organize, analyze, and operationalize knowledge from diverse disciplines: ranging from policy documents and stakeholder insights to technical data and case studies into a searchable, structured information hub. The BPiBS graph database structures information as nodes (entities) and relationships (connections) to reflect the complex interdependencies across housing and building systems (e.g., ventilation, water systems, construction materials), stakeholders (e.g., regulators, builders, community actors), and roadmap elements (e.g., current practices, future goals, enabling activities). The model enables flexible querying and visualization of data clusters, pathways, and bottlenecks.

In practical terms, the graph database supports multi-layered exploration of innovation pathways aligned with the BPiBS thematic areas and dynamic linking of stakeholder contributions to roadmap components, ensuring transparency and traceability from listening sessions to implementation. The repository is hosted on a secure server environment through the University of Victoria, with controlled access for project partners. Planned future steps include the development of interactive web dashboards using tools such as Cytoscape.js, enabling broader access and engagement.

To make the repository accessible and functional for diverse users, we are working on integrating Artificial Intelligence (AI) tools for natural language processing (NLP) and semantic search. These capabilities enable users to for example ask plain-language questions (e.g., "What retrofit practices reduce carbon emissions in rural housing?") and receive context-specific answers derived from the graph.

Practical Implementation of the Graph Database approach enables in the BPiBS project enables to:

- Track and update roadmap elements in real time, based on new data or stakeholder input.
- Monitor alignment with the BPiBS core values: affordability, sustainability, wellbeing, equity, and adaptability.
- Facilitate cross-sector collaboration by acting as a shared digital reference point for co-design and implementation.

By embedding the digital knowledge repository into the BPiBS methodology, the project ensures that AI, ML, and graph technologies are not theoretical add-ons, but practical enablers of systemic change, structured decision-making, and scalable impact.

2.2.4 Structured Roadmap and Strategic Pathway Development

The BPiBS roadmap is the project's core deliverable—a cross-sector building systems planning tool structured around five thematic areas of interest: 1) Health and Lifestyle Systems; 2) Building Exteriors and Grounds; 3) Building Forms and Structures; 4) Water and Waste Systems; and 5) Energy and Thermal Systems. In BPiBS, building systems are integrated networks of structural, infrastructural, and socio-environmental elements that enable built environments to function, adapt, and support life. In housing, they include the material, technological, regulatory, and human components that co-create the places we call home. As such, health and lifestyle systems integrate ventilation, air and water quality control, daylighting, and inclusive, flexible layouts to support occupant well-being. Building exteriors and grounds use green infrastructure—permeable surfaces, native planting, and shared outdoor spaces—for stormwater management, heat mitigation, and social interaction. Forms and structures employ passive design, efficient materials, and adaptable layouts to optimize thermal performance and accommodate changing household needs. Water and waste systems feature greywater reuse, rainwater harvesting, and low-impact waste management to enhance sustainability and reduce infrastructure loads. Energy and thermal systems combine high-performance envelopes, smart automation, and renewable energy (solar, V2B, waste heat recovery) to improve comfort, reduce emissions, and support grid resilience across diverse housing contexts.

Each of these focus areas will be used to organize the Three Horizons framework used in the project methodology to identify the current state and future state of buildings systems and to co-create pathways to transition from the present to the desired future state. Insights from collaborative stakeholder engagement, literature reviews, and regulatory analysis will inform strategic priorities and practical implementation strategies. In addition, roadmap outputs may include: retrofit and design guidelines; regulatory recommendations; pilot project frameworks and innovation concepts; training and workforce development tools; use cases and implementation pathways; these outputs are guided by three roadmap criteria—feasibility, holistic system alignment, and lifecycle integration—and five core values: affordability, sustainability, wellbeing, equity, and adaptability. The roadmap aims to be a dynamic resource, iterated and updated through applied testing and regional customization.

2.3 Knowledge Mobilization

To support wide adoption and integration, BPiBS will embed a proactive knowledge mobilization strategy. Outputs may be shared through:

- Regional and national conferences, webinars, and workshops
- Sectoral regulatory dialogues and roundtables
- Educational platforms for training and workforce development
- Digital dissemination tools, including an open-access roadmap dashboard
- Other dissemination strategies as identified throughout the project

The knowledge mobilization strategy will ensure that roadmap insights are practical, scalable, and continuously refined through real-world applications and ongoing stakeholder engagement.

3. ANTICIPATED OUTCOMES & FUTURE DIRECTIONS

3.1 Capacity Building

Capacity building is key to equipping stakeholders with the knowledge and skills needed to overcome challenges in the housing sector. BPiBS will aim to create opportunities to align research, policy and practice, accelerating the adoption of sustainable building systems. A priority is enhancing curriculum development in trades, architecture and engineering to prepare the future workforce. This includes integrating sustainability, circular economy principles and digital construction technologies into training

programs. Workforce transition and upskilling initiatives will also be explored to support the shift to low-carbon, high-efficiency building practices. By embedding capacity-building into education, industry training and workforce development, the initiative aims to strengthen long-term industry readiness and ensure Canada's building sector is positioned to implement innovative, adaptable and resilient solutions.

3.2 Prospective Future Directions

Pilot projects and real-world applications will serve as testing grounds for innovative building solutions identified through the project process, allowing for the evaluation of feasibility and scalability in localized contexts. To ensure long-term integration, BPiBS may develop implementation strategies that institutionalize sustainable practices within building regulations, policies and industry standards. Expanding successful initiatives across provinces will further enhance impact, with careful consideration of local needs and regulatory landscapes. Collaboration with government, industry and academic partners remains a cornerstone of this strategy. Additionally, BPiBS intends on maintaining the evolving research and innovation roadmap with project partners and stakeholders, continuously refining strategies based on pilot project outcomes, stakeholder feedback and emerging sector trends. By prioritizing collaboration, shared-ownership and knowledge-sharing, this project can support Canada's building industry to be more resilient, sustainable and future-ready.

4. CONCLUSION

4.1 Call to Action

Addressing the complex challenges facing Canada's housing and building sectors will require coordinated, cross-sectoral efforts. The BPiBS initiative encourages continued engagement from professionals across industry, academia, and the public sector to contribute technical expertise and applied insight. Ongoing collaboration and knowledge exchange will be critical to advancing practical, scalable solutions that support long-term sectoral transformation.

4.2 The Future of BPIBS

Looking ahead, the BPiBS project will focus on expanding partnerships, refining methodologies, and scaling impact across Canada's housing sector. Strengthening cross-sector collaboration will support knowledge exchange and accelerate innovation. Methodologies will continue to evolve through iterative design and stakeholder feedback to ensure solutions remain data-driven, effective, and responsive to emerging challenges. To scale impact, BPiBS aims to embed best practices into policy frameworks, support capacity-building, and promote widespread adoption of co-designed solutions—advancing sustainable, affordable, and resilient housing at a systemic level.

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