Author/s:
Qian, Y;Amarasinghe, I;Dissanayake, H;Samarawickrama, S;Gunawardena, T;Mendis, P;Aye, L

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Yi Qian, Isuri Amarasinghe, Harshani Dissanayake, Sasindu Samarawickrama, Tharaka Gunawardena, Priyan Mendis & Lu Aye

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Linking Forest Carbon Accounting and Timber Construction: Australia’s Readiness in the COP28 Decarbonisation Context

Yi Qian [a], Isuri Amarasinghe [a], Harshani Dissanayake [a], Sasindu Samarawickrama [a], Tharaka Gunawardena [a]*, Priyan Mendis [a], Lu Aye [b]

[a] *Department of Infrastructure Engineering, Faculty of Engineering and Information Technology, The University of Melbourne, Victoria 3010, Australia.*

[b] *Renewable Energy and Energy Efficiency Group, Department of Infrastructure Engineering, Faculty of Engineering and Information Technology, The University of Melbourne, Victoria 3010, Australia.*

* Corresponding author. Email address: tgu@unimelb.edu.au (Tharaka Gunawardena).

Abstract

Sustainably sourced timber is increasingly recognised as a climate-responsive construction material that can substitute emissions-intensive products while storing biogenic carbon in wood building products (WBPs). Following COP28, international initiatives continue to integrate forestry, carbon accounting, and construction policy into national decarbonisation pathways. In Australia, however, the extent to which forest carbon data and accounting frameworks support long-lived carbon storage in buildings remains unclear. This paper reviewed global initiatives and regulatory mechanisms promoting timber in construction, examined Australia’s forest resource base, trade balance, and institutional settings shaping domestic timber availability, and assessed how existing carbon accounting and policy frameworks capture linkages between forest carbon dynamics and wood use in buildings. Synthesised national data indicate that softwood plantations supply nearly all construction-relevant products, while hardwood plantations and native forests play minor roles under current conditions. Based on indicative national statistics for 2021–22, the carbon embodied in domestically produced panels equates to roughly 0.63 Mt C (≈ 2.3 Mt CO_2eq), corresponding to an estimated 3.1–5.6 % of total harvested-wood carbon. This indicative range highlights both the measurable yet limited contribution of long-lived WBPs and the need for more detailed, end-use-specific data. Current Australian accounting frameworks quantify forest and product carbon separately, underscoring the need for integrated, time-resolved tracking. These findings clarify measurable boundaries for timber’s role in Australia’s decarbonisation goals and provide a foundation for coherent carbon accounting across the forest–wood–building chain.

Keywords: Conference of the Parties (COP), built environment, Australia, timber building, building decarbonisation

1. Introduction

The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) is a pivotal global forum addressing climate change. COP28, held in late 2023, marked a significant milestone with the completion of the first Global Stocktake (GST), a comprehensive assessment of collective progress towards the goals of the Paris Agreement. The GST evaluates global efforts to limit temperature rise to 1.5 °C above pre-industrial levels and to address the adverse impacts of climate change. Despite its significance, the GST faces persistent challenges, including longstanding issues with implementing international climate policies, which have often hindered progress under earlier UN agreements [1]. The urgency of climate action is underscored by the extreme climatic events experienced in 2023, with global temperatures reaching record highs. Projections now suggest that the 1.5 °C threshold could be exceeded as early as 2026, far earlier than the original 2100 target [2].

The construction industry is a consistent focus of climate discussions, as it accounts for nearly 40% of annual global CO_2 emissions, 28% from building operations and 11% from material production and construction activities [3]. At COP28, 17 countries, representing 26% of global timber production, committed to increasing timber use in the built environment by 2030 [4]. This step is significant for reducing emissions and enhancing long-term carbon storage in buildings, linking forestry and construction sectors.

During COP28, the governments of France and Morocco, in partnership with the United Nations Environment Programme (UNEP), launched the Buildings Breakthrough initiative, aiming to mobilise a coalition of countries to promote climate-resilient and near-zero emissions buildings by 2030. The Global Alliance for Buildings and Construction (GlobalABC), together with the Forest and Climate Leaders’ Partnership (FCLP), the BuildingToCOP Coalition, and the High-Level Climate Champions Team, also introduced the “Greening Construction with Sustainable Wood” initiative, highlighting the essential role of timber in future sustainable construction [5].

Timber-based construction featured prominently in discussions at COP28, reflecting growing recognition of its environmental and structural benefits. For example, the role of repurposing end-of-life (EoL) timber products was emphasised by Nitasa Sikman, interim CEO of the Australian Forest Products Association (AFPA) [6]. She stressed that with the World Bank forecasting a fourfold increase in timber demand by 2050, governments must incentivise rapid plantation establishment to meet future demand [7]. Edgar Hertwich, International Chair in Industrial Ecology at the Norwegian University of Science and Technology (NTNU), presented findings suggesting that in G7 nations, material-related emissions could approach net zero, partly through carbon offsets from sustainable wood use in construction [8]. Similarly, Sheam Satkuru, Executive Director of the

International Tropical Timber Council (ITTO), highlighted that while the forest and wood products sector contributes a relatively small share of global greenhouse gas (GHG) emissions, it offers important benefits, including carbon sequestration and storage, alongside social, economic, and environmental contributions [9].

To ensure terminological clarity in carbon flow analysis, this study distinguishes between three categories of wood-based materials. Harvested Wood Products (HWPs) are defined following IPCC guidelines as all wood materials derived from forests, including logs, bark, and chips, which may be transformed into various products [10]. Within this broader category, Wood Building Products (WBPs) refer to all wood products used in the built environment, encompassing sawnwood, plywood, particleboard, oriented strand board (OSB), medium-density fibreboard (MDF), and other structural timber, as reflected in Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) classification of construction-related wood products [11]. Engineered Wood Products (EWPs) form a subset of WBPs and include assembled or processed structural products such as glued laminated timber (glulam), laminated veneer lumber (LVL), cross-laminated timber (CLT), and engineered I-beams (I-joists), as defined by Food and Agriculture Organization of the United Nations (FAO) forest product classifications [12]. This framing ensures relevance to both climate modelling and the construction sector.

As nations accelerate efforts to decarbonise construction, sustainably sourced timber is gaining prominence for its dual role in substituting emissions-intensive materials and storing biogenic carbon in WBPs. International initiatives, such as those launched at COP28, show increasing momentum but also reveal variation in pace and scope across countries. In Australia, despite substantial plantation and native forest resources, the integration of forestry and construction within national decarbonisation strategies has not been comprehensively assessed. This paper addresses that gap by: (1) reviewing global initiatives and regulatory mechanisms that promote the use of timber in construction; (2) examining Australia’s forest resource base, trade balance, and institutional settings that shape domestic timber availability; and (3) evaluating how current carbon accounting practices and policy frameworks can better capture the linkages between forest carbon dynamics and wood use in buildings. Together, these analyses provide a basis for assessing Australia’s readiness to align with COP28 commitments and for identifying pathways to strengthen timber’s role in national decarbonisation strategies.

2. Global progress on building sector decarbonisation

2.1 Role of sustainably sourced timber in emissions reduction

Timber products offer substantial emissions reduction potential in the construction sector through two key mechanisms: substitution and carbon storage. Substitution involves replacing emissions-intensive materials such as concrete and steel with timber, which generally requires less energy across its lifecycle. For example, a modelling study in South Korea estimated that raising timber’s share of construction materials from 6.01% to 14.76% (an 8.75 percentage point increase) would reduce national CO_2 emissions by about 277,000 tonnes annually. Similarly, in Norway, redirecting pulpwood and sawmill residues from paper production to construction materials and textile fibres could avoid over five million tonnes of CO_2 (Mt C) annually [13,14]. Carbon storage, on the other hand, involves the sequestration of carbon within the HWPs themselves. When wood is harvested and used in products, the carbon contained in the wood is stored for varying periods depending on the lifespan of such products. The sustainable forest carbon cycle is shown in Figure 1 [15,16]. For instance, wood products from annual loblolly and shortleaf pine timber harvests across the southern USA store 29.7 Mt C in the year they enter the market. After 120 years, 11.4 Mt C remains stored [17]. Zhao et al. (2022) found that carbon stored in HWPs is distributed across various end uses (e.g., paper, furniture), landfills, and charcoal (non-energy purposes), with technological advancements in the wood industry enhancing processing efficiency and extending product lifespans, thereby increasing carbon storage [18].

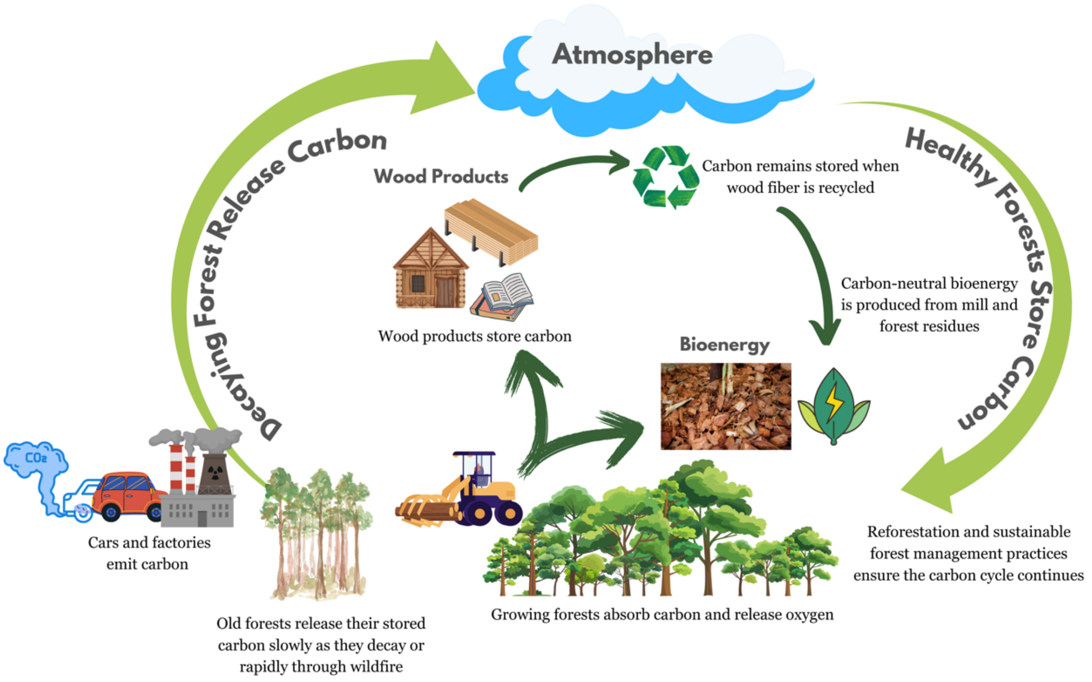

Figure 1. Sustainable forest carbon cycle (Adopted from[16])

Churkina et al. (2020) found that storing carbon in buildings using mass timber has significant advantages over other engineered carbon sinks [19]. The study projects that between 2020 and 2050, 2.3 billion additional residents will require new housing and commercial infrastructure worldwide.

Meeting this demand with conventional materials would generate approximately 0.53 Gt CO_2eq in annual emissions, based on an average floor area of 30 m^2 per person. By contrast, substituting timber could avoid about 0.52 Gt CO_2eq annually, while also storing a further 0.15 Gt CO_2eq in the global building stock. A transition to bio-based building materials can indeed serve as an effective climate mitigation strategy, but its success hinges on sustainable forest management and harvesting practices to prevent forest degradation and soil depletion [20].

Sustainably managed forests play a crucial role in reducing carbon emissions through multiple mechanisms. First, forests act as carbon sinks by sequestering carbon in living biomass, dead wood, and soils, thereby directly reducing atmospheric CO_2 levels [19]. Managed forests can offer better carbon sequestration than unmanaged forests [22] (Figure 2). For instance, Daigneault et al. (2024) demonstrated that improved forest management (IFM) and reforestation practices in Maine, USA, increased sequestration by 15–25% over the baseline while maintaining timber harvests [23]. IFMs, such as Reduced Impact Logging (RIL) in Southeast Asia, have shown to reduce emissions by up to 96.6 Mt CO_2eq while supporting wood production [24]. Additionally, optimisation of forest management strategies, including cutting cycles and afforestation, can increase sequestration by up to 30% compared to unmanaged scenarios [25].

In the Australian context, logging emissions and forest carbon dynamics vary widely across forest types and management regimes. Native hardwood forests such as Mountain Ash generally store more carbon when conserved than harvested [26]. These forests are also highly vulnerable to wildfire, with major fire events in Tasmania (2013) and southeast Australia (2019–2020) contributing significantly to CO_2 emissions and disrupting long-term carbon balance [27,28] In contrast, pine plantations in regions such as southeast Queensland provide opportunities for rapid sequestration due to faster growth, though they rely heavily on effective residue and fire risk management [29]. Logging residues from such plantations can range from 56 to 156 t per ha and represent a substantial post-harvest carbon pool [30]. While partial recovery of this biomass for bioenergy or mulch can enhance overall carbon outcomes, excessive residue removal may reduce soil productivity and disrupt nutrient cycling, limiting long-term sustainability [31]. These trade-offs highlight the importance of context-specific management when evaluating the decarbonisation potential of timber production systems.

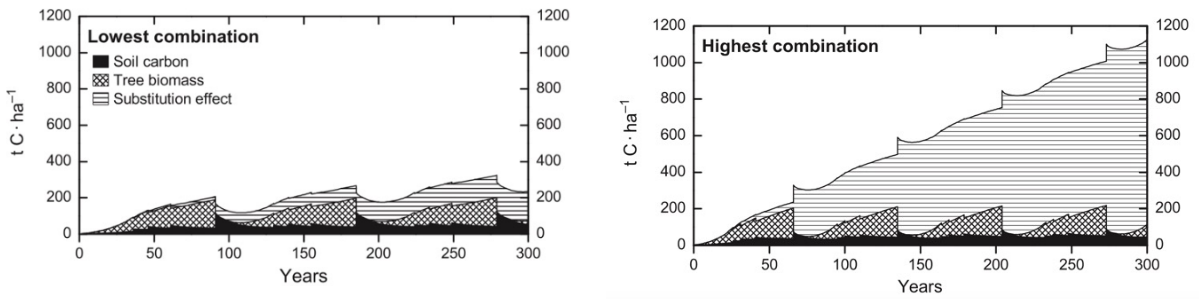

Figure 2. Carbon pool from unmanaged (left) and managed (right) forest (Retrieved from [22])

2.2 Decarbonisation goals for the building sector

In the context of setting decarbonisation targets for the building sector, national and regional approaches appear to vary significantly, reflecting different levels of ambition and capability. For instance, the European Union’s (EU) target is to achieve net-zero emissions by 2050, with interim goals to reduce emissions by at least 55% by 2030 compared to 1990 levels. This aligns closely with the global targets set by the Paris Agreement, which aims to limit global warming to well below 2 °C above pre-industrial levels, with efforts to limit the increase to 1.5 °C [32]. In contrast, some regions, such as certain states of the USA, have set more aggressive targets. California, for example, aims to achieve carbon neutrality by 2045, which is more ambitious than the federal target of net-zero emissions by 2050. This reflects a regional commitment to exceed global targets, potentially serving as a model for other regions to follow [26] . However, not all countries or regions are on track to meet these ambitious goals. In some developing countries such as India, the focus remains on balancing economic growth with environmental sustainability, which can lead to less aggressive decarbonisation targets. These regions often require international support and technology transfer to align more closely with global targets [34,35].

Table 1 summarises the global organisation or coalition decarbonisation goals for building sector. Goals are ambitious, as it involves a comprehensive transformation of energy use and infrastructure. This transformation is supported by various strategies, including enhancing energy efficiency, increasing the use of renewable energy, and implementing integrated planning and policy measures. At COP28, 28 countries launched the Buildings Breakthrough plan, set the vision for “making near-zero emissions and climate resilient buildings the new normal by 2030”. Subsequently, the Global Forum on Architecture and Climate held in Paris, France in March 2024 put the process on track [36].

Table 1. Building sector decarbonisation goals

Organisation/Coalition	**Time**	**Goals**	**Reference**

EU	2024	All new buildings should be zero-emission as of 2030; new buildings occupied or owned by public authorities should be zero-emission as of 2028. Achieving the decarbonisation of all building stock by 2050.	[37]
World Green Building Council (WorldGBC)	2021	Halving emissions of the building and construction sector by 2030 and the total decarbonisation of the sector by 2050.	[38]
Race to Zero	2020	All new projects completed from 2030 are net zero carbon in operation, with >40% reduction in embodied carbon	[39]
Climate Action Pathway	2021	All countries have national roadmaps for decarbonising the built environment by 2025; 100% of new buildings must be net-zero carbon in operation and embodied carbon must be reduced by at least 40% by 2030; all new and existing assets must be net zero across the whole lifecycle by 2050	[40]
IEA	2021	From 2030, all new buildings are zero-carbon-ready; ban new gas boilers from 2025; most appliances and air conditioning systems reach premium quality by 2035; more than 85% of buildings need to comply with zero-carbon-ready building energy codes by 2050	[41]
Buildings Breakthrough	2023	Making near-zero emissions and climate resilient buildings the new normal by 2030	[35]
Greening Construction with Sustainable Wood	2023	Increase the use of wood in the built environment by 2030	[42]

2.3 Current progress and delays

Oliver Rapf, Executive Director of the Buildings Performance Institute Europe, noted at COP28 that "*growing global buildings and construction emissions and slowing investments and policy efforts highlight that we are not on track*." This concern is reinforced by recent evidence. By 2024, 85 countries had adopted national building energy codes for residential buildings and 88 countries for non-residential buildings, of which 80% were mandatory. Yet 20% of mandatory codes still pre-date 2015, raising questions about their adequacy. Although 20 codes have been updated since 2022, and five countries (Kenya, Iceland, Japan, Germany, and Viet Nam) updated codes in 2024, the overall rate of reform remains behind the pace required to meet projected demand growth, particularly as 80% of the projected increase in global floor area to 2030 will occur in emerging economies, many of which lack robust enforcement mechanisms [41,43].

To provide a clearer assessment of systemic gaps, the Global Buildings Climate Tracker (GBCT) was introduced as part of the Global Status Report. The GBCT is a composite index built from seven indicators across three categories (shown as Table 2):

- Emissions: annual building sector CO_2 emissions (used directly as a multiplier)
- Impacts (37% weight): building energy intensity and renewable energy share
- Actions (63% weight): energy efficiency investment, growth in green building certification, Nationally Determined Contributions (NDCs) referencing buildings, and alignment of codes with zero-emission standards

Each indicator is benchmarked against milestones for 2030 and 2050 and aggregated into a dimensionless index of “decarbonisation points,” representing the weighted progress of the global building sector toward full decarbonisation.

As shown in Table 2, progress between 2015 and 2023 has been limited. Sectoral CO_2 emissions rose by 5.4% to 9.8 $GtCO_2$, contrary to the required 28.1% reduction. Building energy intensity decreased by 9.5%, falling well short of the required 18.2% reduction. The share of renewable energy in buildings’ final demand increased by 4.5 percentage points, but this remains below the necessary 17.8 point increase. While cumulative energy efficiency investments reached USD 1,936.2 billion, they remain USD 1.1 trillion short of the required trajectory. Green building certification increased by 9.8 points, but is still 7.7 points below target. Policy alignment is particularly weak: as of 2023, only 19 countries had included detailed building sector actions in their NDCs (6.3%), and just two countries had building codes aligned with zero-energy principles (2.2%) [44,45].

Table 2. GBCT indicators, current progress, and future milestone [43,46]

Indicator	**Starting value in 2015**	**Observed value in 2023**	**2030 milestone**	**2050 milestone**	**Weight**
Emissions					
Buildings sector energy related emissions ($GtCO_2\ yr^{-1}$)	9.3	9.8	4.4	0.0	applied as a factor

Impact					
Building sector energy intensity (kWh m^{-2})	146	132.2	96.2	55.8	19%
Renewable share in final energy demand in buildings (%)	13.0	17.5	18.1	25.0	19%
Action					
Cumulative energy efficiency investment in buildings (USD bn)	161.5	1,936.2	5,586.2	28,374.8	11%
Green building certification (cumulative growth) (point)	1.0	10.8	33.9	96.5	19%
NDC considering buildings extensively (aggregated) (%)	0.7	6.3	75.0	100	15%
Building codes ZEB-aligned (aggregated) (%)	0.0	2.2	75.0	100	18%

Figure 3 complements Table 2 by showing the evolution of the GBCT index from 2015 to 2023. The widening shortfall between observed progress and the GlobalABC reference pathway is evident: by 2023, the gap had grown to 44.3 decarbonisation points. Following a marked increase in 2020 (linked partly to COVID-19 restrictions) and a decline in 2021, the index recovered modestly in 2022–2023, reaching 2.8 points. However, this remains far below the required trajectory of 47.1 points for 2023. The dashed green line shows the stylised pathway towards a zero-carbon building stock by 2050.

Taken together, the GBCT and related monitoring frameworks indicate that the global buildings and construction sector is not yet decarbonising at the scale or pace required. Emissions continue to rise, efficiency gains are lagging, and policy integration remains partial, particularly in emerging economies where floor area growth is concentrated. These findings underline the urgency of accelerating investment, aligning codes with zero-emission standards, and embedding measurable building sector actions in NDCs.

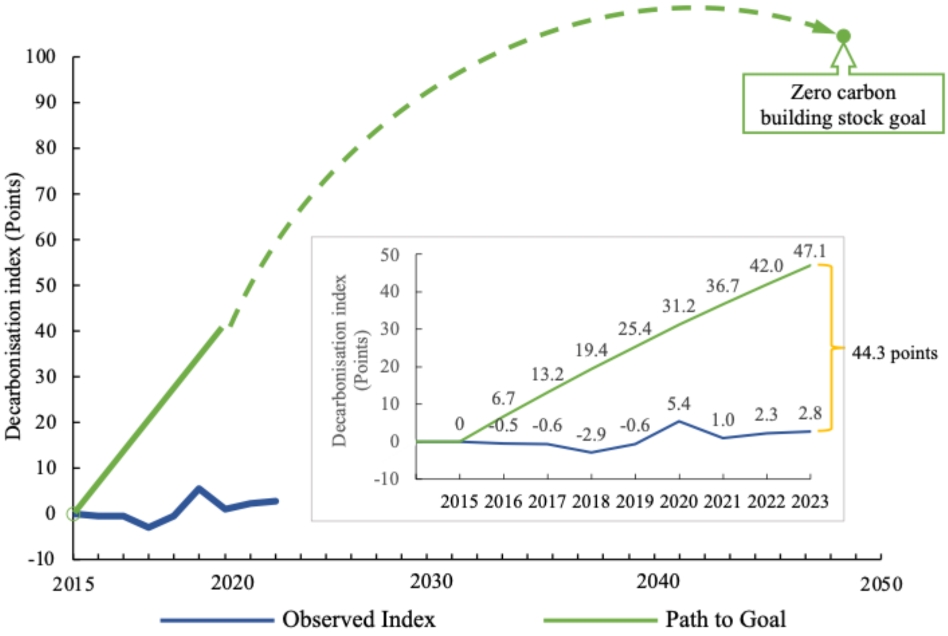

Figure 3. Global building sector decarbonisation trajectory (2015–2050), showing the widening shortfall between observed GBCT index values (blue line) and the GlobalABC reference pathway (green line) [43]

2.4 Building sector decarbonisation roadmap

The *Global Status Report for Buildings and Construction 2024/2025* highlights slow but growing momentum in national and regional planning for building sector decarbonisation. As of 2024, 43 of 194 countries had developed decarbonisation roadmaps, emphasising action across eight priority areas including urban planning, existing buildings, operations, materials, resilience, and clean energy. While this represents progress compared with previous years, it also indicates the scale of implementation still required [43].

At COP28, governments launched the *Buildings Breakthrough*, endorsed by 45 countries representing over 70% of global GDP, with the goal of making "near-zero emission and resilient buildings the new normal by 2030." The initiative identifies six priority areas to drive transformation: (1) standards and certification, (2) demand creation, (3) finance and investment, (4) research and deployment, (5) capacity and skills, and (6) landscape coordination. These areas guide countries in strengthening codes, mobilising resources, and advancing cross-sector collaboration.

Regional examples illustrate how these principles are being operationalised. Turkey's *Zero Carbon Buildings Accelerator Project* has set detailed timelines for construction, demolition, and material use, including Life Cycle Assessment (LCA) requirements, with targets of 80% coverage for commonly used buildings by 2043 and 95% by 2053. Similarly, the Greater Bay Area (GBA) Roadmap in China outlines milestones such as achieving 35%

prefabrication in new construction by 2025, 30% of projects using LCA by 2030, and full coverage by 2060. These cases demonstrate how international frameworks are being translated into national or regional contexts (see Table 3 and Appendix 1) [47–50].

To analyse strengths and limitations systematically, we applied a structured evaluation rubric (Appendix 1), adapted from international climate policy frameworks (e.g., GlobalABC, IPCC). The rubric assesses six dimensions: governance, targets, implementation, financing, monitoring, and innovation, using guiding questions rather than scores. Table 3 synthesises findings across four representative roadmaps (Turkey, United Kingdom, Sweden, and China's GBA).

Table 3. Decarbonisation roadmaps analysis

Roadmaps	**Strength**	**Areas for further development**
Turkey	• Sets a national net-zero target for 2053 with interim milestones (2030, 2043) • Incorporates LCA into policy, addressing embodied carbon • Defines roles for government, industry, and civil society, supporting coordination • Introduces finance platforms to mobilise investment	• High institutional complexity may hinder coordination across sectors • Alignment with EU regulations may require significant domestic adjustment • Financing tools lack specificity, limiting feasibility • Monitoring and reporting mechanisms remain undeveloped • Innovation pathways (e.g., timber, modular construction) are only indirectly referenced
United Kingdom (UK)	• Establishes a legally binding carbon budget covering the entire built environment. • Sets interim milestones (2025, 2030, 2035) for accountability. • Developed through broad stakeholder consultation, enhancing legitimacy • Explicitly addresses both operational and embodied carbon • Defines urgent priority actions for decarbonisation	• Sector-wide approach risks insufficient adaptation to sub-sector needs • Requires extensive data, modelling, and monitoring capacity • Dependent on EU policy shifts, creating uncertainty • Innovation pathways acknowledged but under-specified • Financing mechanisms lack detailed instruments for private-sector mobilisation
Sweden	• Provides a legally grounded framework supported by Nordic and EU governance • Defines a phased trajectory (2022, 2035, 2050) toward net-zero • Integrates operational and embodied carbon in regulation	• Carbon limit values remain under development, creating near-term uncertainty • Timber use referenced without quantified targets • Strong reliance on EU directives may slow domestic innovation

	▯ Recognises timber and bio-based materials as mitigation option ▯ Mandates disclosure, improving transparency and comparability	▯ Monitoring systems lack maturity and comparability ▯ Financing and private-sector incentives are limited
China's GBA	▯ Aligns with national 30–60 targets; sets an earlier emissions peak (2025) ▯ Covers full lifecycle phases from planning to operations ▯ Designed as an adaptive roadmap with iterative updating ▯ Positions the GBA as a demonstration model for wider replication	▯ Current progress lags behind 2030 and 2060 targets ▯ Coordination across 11 cities and 2 SARs increases governance complexity ▯ Timber and wood use not specified as a mitigation pathway ▯ Continued reliance on fossil and nuclear energy in early years delays renewables uptake ▯ High financial and institutional capacity requirements challenge implementation

Beyond these four cases, some countries are developing sector-specific approaches. For example, Canada's *Mass Timber Roadmap* sets quantifiable market and supply-chain targets, illustrating how sector-specific plans can complement broader national decarbonisation strategies [51]. Comparable initiatives are emerging in Europe and Asia, where timber strategies are increasingly integrated into national climate and housing policies, while several Latin American roadmaps remain inaccessible in English, limiting comparative analysis [43]. Existing roadmaps nonetheless reveal shared challenges: first, ambiguity about whether tracking and reporting are compulsory or voluntary reduces accountability, though the UK's hybrid model of mandatory standards with voluntary ratings offers a pragmatic approach. Second, some goals remain difficult to measure, for instance, Turkey's green finance initiatives illustrate the challenge of linking awareness programmes to concrete investment shifts. Third, accessibility and transparency are uneven, underscoring the need for internationally comparable datasets and monitoring mechanisms.

2.5 Global initiatives and regulations promoting sustainable timber construction

As part of global efforts to mitigate carbon emissions from the construction industry and promote sustainable timber construction, a range of international initiatives and regulations encourage the use of timber as a renewable and low-carbon material. These initiatives include forest certification schemes, carbon pricing mechanisms, government regulations and incentives, and green building certifications. Table 4 highlights some of the leading initiatives around the world that support global efforts on timber construction and align with the goals of the Paris Agreement.

Table 4. Global initiatives promoting sustainable timber construction

Initiative type	**Initiative name**	**Aim**	**Current Outcomes**	**Area(s)**
Government regulations, funding and incentives	Law on Promotion of Wood in Public Buildings, Law No. 36 of 2010.	Promote use of timber for buildings, conserve forest land and activate the economy of mountain villages	Obligates the national and local governments to utilise wood materials for public buildings that have three stories or less.	Japan [52]
	Green Construction through Wood (GCWood) Program	Funding and investing in the use of innovative wood-based building technologies in construction projects	Successfully funded 16 timber construction projects and developed the "Interactive State of Mass Timber in Canada Dashboard".	Canada
	REDD+ by Green Climate Fund	Provide incentives to reduce deforestation and promote sustainable forest management	Approval for results- based payments for over 8 projects in different countries for mitigation	Global [53,54]
Carbon pricing mechanisms	European Union Emissions Trading System (EU ETS)	Use a "cap and trade" principal to limit amount of GHG emitted while generating revenue to finance green transition through a carbon market	Increased cost of carbon-intensive material has encouraged construction projects to opt for more renewable material such as timber.	EU
	National Carbon Tax	Encourage emission reduction by assigning a cost to each ton of CO_2 emitted.	Successful implementation accounts for at least a third of total national emission reductions between 1991 and 2015	Sweden [55,56]
Forest Certification Schemes	Programme for the Endorsement of Forest Certification	Verification of chain-of-custody to demonstrate that timber originates from certified forests managed under sustainability	Development of policies, frameworks, and certification requirements to be adopted	Global [57]

		standards; certification does not extend to broader supply-chain conditions (e.g., legality, labour standards)		
	Forest Law Enforcement, Governance, and Trade (FLEGT)	To reduce illegal logging through by promoting legal timber production, improved governance and sustainable forest management	Establishing Voluntary Partnership Agreements, which are legally binding trade agreements on timber-exporting	EU [58]

In addition to these initiatives, green building standards and certifications such as the Leadership in Energy and Environmental Design (LEED) and the Building Research Establishment Environmental Assessment Method (BREEAM) encourage the use of sustainable materials, including certified timber in construction. Projects can earn points for incorporating environmentally responsible practices by using these materials, making these certification schemes a powerful driver for the adoption of sustainable timber in construction practices.

The global efforts and regulations promoting sustainable timber construction represent a multifaceted approach to reducing the carbon footprint of the construction industry. These initiatives collectively contribute to the growing acceptance of timber as a renewable, low-carbon building material, while supporting the global climate goals set out in the Paris Agreement and encouraging innovation and responsible sourcing. To meet these goals, and to deliver on the forest and land-use pledges announced at COP28, more countries will need to adopt comparable initiatives, tailored to local contexts and supported by stronger international collaboration. Importantly, timber construction should be viewed as a tactical response to these strategic goals, with the specific tactical mix varying across national contexts.

3. How COP28 affects Australia

3.1 Australia's current state

Australia possesses one of the most trade-exposed forest and wood products sectors globally, spanning the entire supply chain from log production in managed forests to downstream processing into building-relevant timber products. This sector includes the upstream harvesting of logs, primarily from plantation softwoods and native hardwoods, as well as the downstream conversion into sawn wood, veneered products, and EWPs used in the built environment. Due to its significant exposure to global market forces, shifts in international trade patterns and regional supply constraints have a direct impact on domestic timber availability, pricing, and investment decisions across the sector.

The National Construction Code (NCC) has increasingly acknowledged timber's role in decarbonisation. Recent amendments permit greater use of timber in mid-rise buildings through expanded Deemed-to-Satisfy (DTS) provisions. However, key Australian Standards, particularly AS 1720 and AS 1684, have not kept pace with advances in timber engineering. Unlike international codes such as the American Wood Council's NDS [59], Australia's standards lack detailed design provisions for mass timber products like CLT and glulam. As Smith and Foliente (2002) noted, these standards rely heavily on empirical methods and lack modern probabilistic reliability models [60], limiting their application to innovative timber systems. Additionally, their support for advanced connection technologies remains limited [61], thereby constraining wider uptake of performance-based timber design despite increasing industry capacity.

In December 2023, the Forestry Ministers' Meeting (FMM) was held as Australia joined the international *Sustainable Wood Greening Buildings Program*. Ministers identified five priorities for the forestry sector: improving resource security and domestic supply, expanding timber and wood product production, strengthening the role of forestry in climate mitigation, increasing opportunities for the timber industry workforce, and ensuring continued sustainable forest management [62]. The meeting also committed to accelerating the review of the National Forest Policy Statement and developing a 50-year outlook that incorporates short-, medium- and long-term perspectives, recognising both the persistence of investment cycles and the significant role of wood products in meeting housing and energy infrastructure needs. In July 2024, the FMM announced AUD 1.8 million in the 2024–25 federal budget to support participation in this review, alongside commitments from states and territories to increase production and meet consumer demand, especially in construction [63].

Australia has implemented several initiatives at both national and subnational levels to support sustainable forestry and timber use in construction. Table 5 outlines a mix of national programs, such as forest certification schemes, industry research funding, and large-scale tree planting strategies, alongside localised policies like the Wood Encouragement Policy. While some initiatives, including forest certification, may not directly promote timber construction, they are fundamental in aligning forestry practices with sustainability objectives and global climate goals.

Table 5. Australian initiatives promoting sustainable timber construction

Initiative type	Initiative name	Implemented Area (s)	Description

Government regulations, funding, and incentives	Wood Encouragement Policy (WEP)	Western Australia, Tasmania, 2 local government authorities and 18 local councils	Requires responsibly sourced wood to be considered where feasible as the primary construction material in all public new-build and refurbishment projects [64].
	Clean Energy Finance Corporation (CEFC) Timber Building Program	Nation-wide	Encourage greater use of mass timber in construction by providing financing to projects using low carbon EWPs [65]
	Australian Forest and Wood Innovations	Nation-wide	Funding research initiatives that benefit the Australian forest and wood product industries [66]
Forest Certification Schemes	Responsible Wood programme	Nation-wide	Aligns with international standards such as PEFC and ensures the timber sourced are from sustainable managed forests [67]
	Forest Stewardship Council Australia	Nation-wide	Administrating as a part of the international organisation FSC, to certify forests in Australia [68]
Other Initiatives	A Billion Trees for Jobs and Growth	Nation-wide	Launched in 2018 under a previous federal government, aiming to plant a billion trees over the next decade to meet timber and wood fibre demand by establishing regional forestry hubs, support new infrastructure business cases, and assess plantation expansion near existing wood and fibre sources [69]

While these initiatives reflect growing policy engagement across jurisdictions, their collective impact remains limited by the lack of a cohesive national strategy that integrates forest resource planning, carbon reduction targets, and construction sector demand. Without such integration, opportunities for timber to play a central role in Australia’s climate transition and housing agenda may remain under-realised. This gap underscores the need to assess Australia’s current timber capacity and the extent to which domestic supply can meet rising demand anticipated under climate and housing commitments, reinforced by international agreements such as COP28.

3.2 Current capacity and future demand for timber in Australia

3.2.1 Timber availability in Australia

Australia’s forest and wood-based construction materials sector plays a critical role in supplying materials for the domestic construction industry. However, not all forest-derived products contribute to long-lived WBPs used in buildings. This section focuses on the supply of logs used for construction-related wood products, specifically sawnwood and wood-based panels, while excluding pulpwood, bark and other industrial roundwood, which are not used for construction [70].

In 2022–23, the commercial plantation estate totalled 1.71 million ha (Mha), comprising 1.01 Mha of softwood (59%) and 0.68 Mha of hardwood (40%). Hardwood plantation area has declined by nearly 0.25 Mha over the past decade, reducing its contribution to supply [11]. Currently, sawn softwood from plantations forms the backbone of structural timber production and is processed at scale into both sawnwood and EWPs [71].

Native hardwood sawlogs are mainly converted into appearance-grade products such as flooring, joinery, and cladding, while veneer logs are processed into plywood or decorative veneers at a limited number of mills [72]. Although smaller in volume, these outputs remain critical for product diversity and for supplying long-lived WBPs.

Plantation hardwood logs are exported predominantly as pulpwood, with limited domestic processing. Infrastructure constraints have restricted their role in WBPs, although with investment they could provide an additional resource for EWP production [11,73].

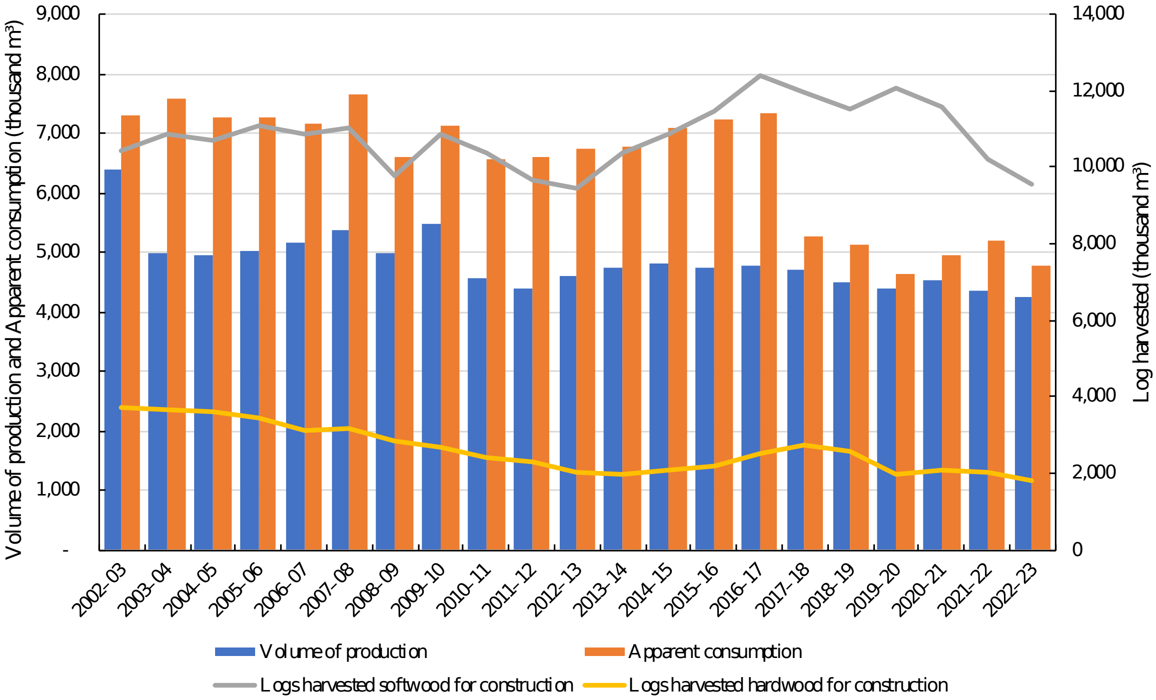

Figure 4. Log harvest, production volume, and apparent consumption of WBPs used in buildings [11]

Figure 4 illustrates the persistent imbalance between domestic production and consumption of sawnwood and wood-based panels. Over the past two decades, imports have increasingly met demand: in 2002–03, imports supplied ~15% of sawnwood consumption, rising to ~33% by 2021–22. For wood-based panels, imports accounted for ~12% of apparent consumption in the early 2000s, increasing to ~26% in recent years [11]. While fluctuations in softwood harvesting mirror cycles in mill demand and housing activity, the long-term trajectory shows a widening structural gap between national output and consumption.

It is also important to note that the apparent decline in wood-based panel consumption after 2016–17 reflects changes in ABARES reporting rather than an actual contraction in demand. From 2017–18, data for particleboard and MDF were withheld due to confidentiality constraints. As these materials remain widely used in residential interiors, their exclusion complicates interpretation of post-2016 consumption trends [11].

3.2.2 Timber imports and market influence

International trade plays a critical role in meeting Australia's demand for timber products used in construction, largely due to a growing gap between domestic supply and consumption. Figure 5 illustrates import and export volumes for sawnwood and wood-based panels, drawing on data from the Australian Forest and Wood Products Statistics (AFWPS). Over the past two decades, imports have consistently exceeded exports, reflecting Australia's reliance on overseas supply to meet material demand. Export volumes have remained relatively low and stable, indicating limited surplus capacity in domestic production for building-relevant wood products [11].

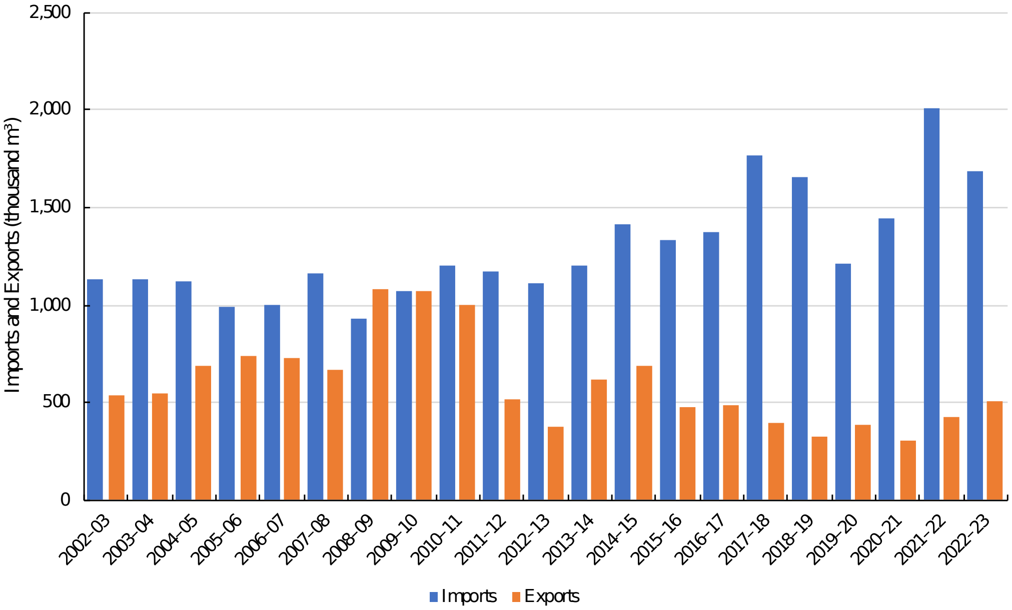

Figure 5. Imports and exports of sawnwood and wood-based panels for timber construction [11]

The trade imbalance highlights Australia’s growing dependence on international markets to supply a wide range of timber products, including structural, appearance, and industrial categories. At the same time, it points to opportunities for expanding domestic capacity through investment in manufacturing infrastructure, particularly facilities for EWPs [74]. Reducing reliance on imports will likely require a balanced approach that mobilises all suitable sources permitted under sustainability and regulatory frameworks, including plantations, responsibly managed native forest outputs, and recycled fibre.

In the near term, improvements can be achieved by increasing recovery from existing plantations, making selective use of certified native forest material for appearance and specialty applications, and improving design–manufacture data to reduce downgrade and waste [70]. While new plantations remain important for long-term supply, they cannot address short-term demand due to rotation times of several decades. Recent assessments indicate that longer rotations can deliver ecological benefits but are not suited to addressing immediate supply shortfalls [75,76]. A combined strategy that integrates existing plantations, responsibly managed native forests, recycled fibre, and enhanced domestic processing capacity therefore offers a practical pathway to a more secure and resilient timber economy.

3.2.3 Future demand for timber in construction

Australia's population is projected to experience substantial expansion, rising from 25.79 million in 2021 to a range of 33.62 million to 39.67 million by 2050 [77]. This growth will drive a substantial increase in housing demand. By 2050, the total number of dwellings is projected to reach around 15.19 million. Average annual demand for new dwellings is expected to rise from 183,110 units in 2022–2030 to 258,620 units in 2046–2050, while actual formation rates are estimated to remain lower, at 152,220 and 212,360 units respectively [78]. Figure 6 presents projected demand for sawn softwood alongside forecasts of dwelling formation to 2050. The figure illustrates the close relationship between population-driven housing growth and timber requirements, showing how demand for wood products is expected to accelerate in line with dwelling construction.

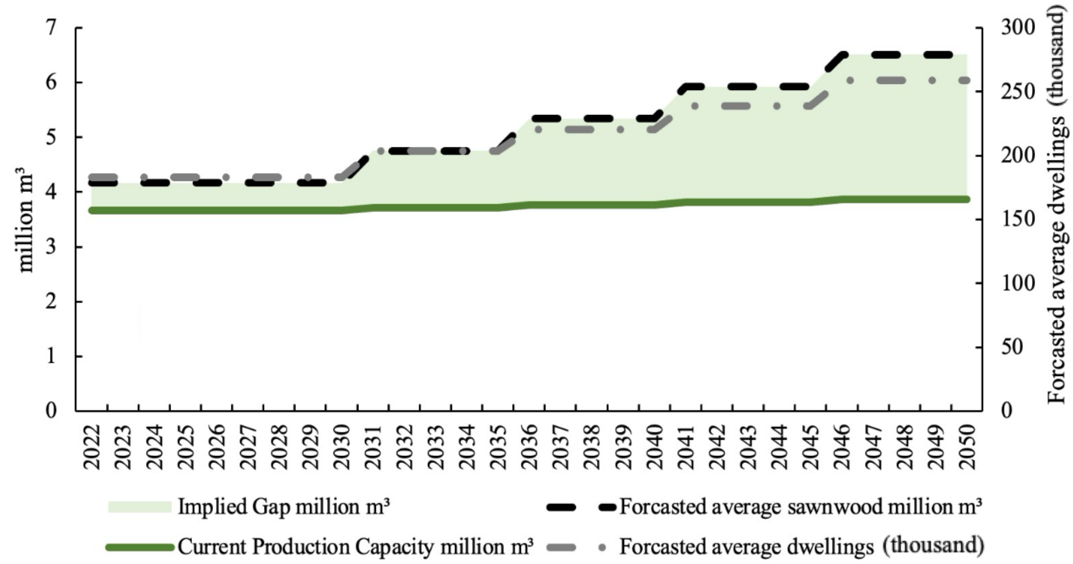

Figure 6. Australian sawn softwood demand and forecasted average dwellings

Rising residential development will substantially increase demand for a wide range of timber products, including sawn softwood, wood-based panels such as MDF and particleboard, and appearance and specialty timbers used in flooring, joinery, and interior applications. Demand for sawn softwood alone is projected to increase from 4.17 million m³ in 2022 to around 6.51 million m³ by 2050, a compound annual growth rate of 1.3%. In contrast, current domestic production capacity is estimated at 3.6–3.8 million m³ per year, with an annual growth rate of only 0.2%. This widening imbalance indicates that additional supply will be required through imports or by mobilising underutilised domestic resources [78].

The anticipated increase in sawn softwood demand is closely tied to Australia's population growth and the corresponding need for housing. Despite fluctuations in apparent consumption due to inventory adjustments and construction backlogs, the overall trend indicates a significant rise in demand, which will need to be met to accommodate the growing population for a continuing strong pipeline of building work, emphasising the importance of planning to meet future timber supply needs.

3.3 Carbon flow from forest to construction: tracing biogenic carbon into long-lived wood building products

This section traces how biogenic carbon flows from forest areas supplying construction-relevant timber into WBPs used in the built environment. The focus is not on a comprehensive carbon balance across all HWPs, but rather on the smaller subset of wood that is transformed into durable construction. This distinction is critical: while HWPs encompass all material harvested from forested landscapes, only a portion enters the construction sector and contributes meaningfully to long-term carbon storage. Aligning with COP28’s emphasis on material-specific mitigation pathways, this section narrows the system boundary to include only forest types and harvested volumes that currently supply or could feasibly supply WBPs. It accounts for major shifts in forest policy, such as the 2024 cessation of native forest harvesting in Victoria and Western Australia(WA), and clarifies the limited domestic role of plantation hardwoods. By narrowing the system boundary to the timber actually entering Australian buildings, the analysis provides a more realistic basis for assessing timber’s embodied carbon and storage potential.

3.3.1 Forest resources supplying the timber and construction sector

Australia’s wood supply is drawn from a combination of multiple-use public native forests, private native forests, softwood plantations, and hardwood plantations, which together supply HWPs. Only a portion of these HWPs is processed into WBPs, such as sawnwood, plywood, LVL, and CLT, that are directly relevant to the construction sector [79,80].

Native forests: Multiple-use public native forests, dominated by *Eucalyptus* species (e.g., *Eucalyptus regnans*), are managed under integrated objectives, including wood production, biodiversity conservation, and water regulation. In 2022–23, the net harvestable area of these forests was estimated at 4.3 Mha, concentrated in Victoria, Tasmania, New South Wales (NSW), and WA. However, both Victoria and WA ceased commercial harvesting of public native forests in January 2024, reducing the effective harvestable area to approximately 2.8 Mha [79–81].

Forests on leasehold and private tenure also contribute to wood supply in some states, particularly Queensland and NSW, but their overall commercial significance remains limited. In 2021, the combined area of native forest across leasehold, private, and multiple-use public tenures suitable for commercial wood production was 27.4 Mha, although most privately managed forests have low commerciality ratings and restricted accessibility [80,81]. Harvest data for private native forests are relatively scarce, with only partial figures reported for Tasmania and Queensland. Overall, these forests represent a regionally relevant but nationally minor component of Australia’s wood supply. Their role remains constrained by limited data availability and low commerciality, though some regional dependence may increase as harvesting from public native forests declines.

Softwood plantations: Predominantly consisting of *Pinus radiata* and *P. elliottii*, softwood plantations are the main domestic source of WBPs and EWPs. They provide feedstock for structural framing, LVL, and CLT, which are critical for the construction sector. In 2022–23, softwood plantations covered approximately 1.06 Mha, with the largest shares in NSW, Victoria, and South Australia, accounting for nearly 60% of the total plantation area [80,82,83].

Hardwood plantations: Hardwood plantations, mainly *Eucalyptus globulus* and *Eucalyptus nitens*, occupied about 0.74 Mha in 2022–23, primarily in WA, Victoria, and Tasmania. Most hardwood plantation outputs are directed to pulplogs and export markets, with a currently minor contribution to domestic WBPs. Nevertheless, these plantations represent a potential resource for value-added construction products if domestic processing capacity improves [79,84].

Figure 7 presents the estimated area of harvestable forests (native and plantation) across six key states. Softwood plantation data (1.06 Mha in 2022–23) and hardwood plantation data (0.74 Mha) are derived from ABARES (2023) [80], while the harvestable area of public native forests (4.3 Mha, pre-2024) is estimated from narrative accounts in the same source. Where state-level breakdowns were unavailable, proportional allocations were made using qualitative indicators (e.g., “most of the harvestable area is in Victoria and Tasmania”), as detailed in Appendix Sheet 3.

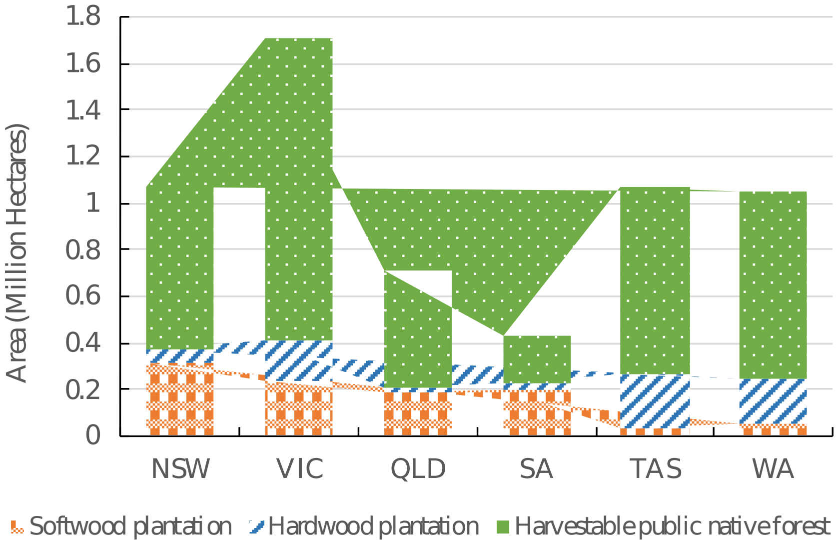

Figure 7. Estimated area of harvestable forests (native and plantation) by state (2022–2023)

Note: Native forest values for Victoria and WA are based on 2022–2023 data. Public native forest harvesting ceased in both states from January 2024 [81], and these states are excluded from any post-2024 analysis.

3.3.2 Carbon sequestration and harvest emissions

The forest resources outlined earlier not only provide raw materials for WBPs and EWPs but also act as dynamic carbon reservoirs throughout their growth and harvest cycles. Quantifying the carbon uptake of these forests is critical for understanding the biogenic carbon embedded in timber entering the construction sector.

Softwood plantations dominate Australia's construction timber supply, and these plantations have annual sequestration rates ranging from 1.0–3.5 tC ha^{-1} yr^{-1}, depending on species, site productivity, and management intensity. Grace & Basso (2012) report values around 2.1–2.8 tC ha^{-1} yr^{-1} for high-yield *Pinus radiata* plantations in the Green Triangle and coastal NSW [85]. Hardwood plantations, while currently focused on pulpwood exports, can sequester 3.0–8.0 tC ha^{-1} yr^{-1}, particularly in *Eucalyptus globulus* and *E. nitens* stands across Tasmania, Victoria, and WA [86]. These plantation sequestration values represent the primary carbon input into HWPs and, subsequently, into WBPs and EWPs used in the construction sector. Linking these rates to harvested volumes allows a more accurate estimation of the carbon embedded in building-relevant wood products. These values are summarised in Table 6.

Table 6. Average aboveground carbon sequestration rates for key plantation forest types in Australia

Forest type	**Sequestration rate (tC ha^{-1} yr^{-1})**	**Key regions**	**References**
Softwood plantations	1.0–3.5	NSW, Victoria, SA, Green Triangle	[85]
Hardwood plantations	3.0–8.0	TAS, Victoria, WA	[86]

Beyond sequestration potential, emissions arising from timber harvesting operations significantly influence the net carbon balance of production forests. Mechanised logging processes, especially in cut-to-length systems, consume diesel fuel and generate emissions predominantly in the form of CO_2. Kärhä et al. (2024) emphasise that fuel consumption and productivity are key drivers of these emissions [87]. Soil disturbance during harvesting also plays a role: compaction from heavy machinery reduces gas exchange, potentially shifting soils from methane sinks to sources [88]. Furthermore, vegetation removal and soil disruption can increase mercury volatilisation, particularly under dry conditions [89].

Branches, bark, and stumps left on-site decompose and release CO_2, and in anaerobic conditions, CH_4 and N_2O [90]. While burning or using residues for bioenergy can offset some fossil emissions, these benefits depend on transport distances and soil carbon trade-offs [91,92]. A growing body of research suggests that biochar produced from forest residues provides a more durable carbon sink and soil fertility benefits, with studies from Australia and international collaborations [93,94] showing that biochar-based amendments improve soil carbon retention. However, these approaches remain constrained by logistical and economic barriers and should be viewed as complementary mitigation strategies rather than primary solutions.

3.3.3 Carbon storage in wood building products

Biogenic carbon retained in HWPs represents a temporary yet measurable continuation of forest carbon storage. Following harvest, a portion of the carbon fixed in forest biomass remains embodied in sawnwood and wood-based panels used across the built environment. The magnitude and duration of this storage depend on product characteristics, service life and EoL behaviour. Table 7 summarises representative physical and carbon parameters for major Australian wood products, including density, carbon content, lifespan class and recycling or landfill rates, compiled from recent national and international studies [98–105]. These parameters reflect the predominance of *Radiata pine*-based EWPs (e.g., CLT, LVL) while also covering hardwood sawnwood and plywood used in structural and interior applications [95–102].

Table 7. Typical density, carbon content, and lifespan classification of Australian wood products

Product type	**Basic density (kg m⁻³)**	**Carbon content (kgC m⁻³)**	**Lifespan classification**	**Landfill (%)**	**Recycling (%)**	**Sources**
Sawnwood (Softwood)	450–550	225–275	Long (35–50 yrs)	20–40	40–60	[95,99,100]
Sawnwood (Hardwood)	600–850	300–425	Medium–Long (30–40 yrs)	20–40	30–50	[96,99,100]
Plywood	500–700	250–350	Medium–Long (25–40 yrs)	20–30	20–40	[95,99]
Particleboard (structural/flooring)	650–750	325–375	Long (40–50 yrs)	10–30	30–50	[95,101]

Particleboard (non-structural/general)	600–700	300–350	Medium (15–30 yrs)	10–30	30–50	[96,99]
MDF	600–800	300–400	Medium (15–30 yrs)	10–25	20–40	[99,102]
LVL	550–750	275–375	Medium–Long (25–40 yrs)	10–30	30–50	[98,100]
CLT	480–650	240–325	Long (30–50 yrs)	10–25	25–40	[96–98]

Using 2021–22 domestic production of approximately 2.0 million m^3 of wood-based panels and the product-specific carbon contents in Table 7, the embodied biogenic carbon inflow equals about 0.63 Mt C (≈ 2.3 Mt CO_2eq). This value represents the carbon entering manufactured products at the point of production, not the quantity that remains in use. Accordingly, Table 8 is interpreted as a material-flow baseline, a static snapshot of the annual carbon inflow into panel production, rather than representing a fixed stock or direct mitigation outcome. Actual retention depends on service life and product application. Verified datasets compiled by Forest & Wood Products Australia (FWPA) provide these empirical constraints: plywood is primarily used in flooring, wall and roof sheathing and formwork, whereas MDF and particleboard dominate interior joinery and cabinetry [103], These use profiles explain the wide range of service life classes shown in Table 7: roughly 15–30 years for MDF and particleboard, 30–50 years for structural plywood, and 50–60 years for LVL and CLT. Applying these indicative lifespans suggests that a substantial share of the carbon embodied in current panel production is likely to remain in use for several decades before entering disposal pathways.

Table 8. Estimated biogenic carbon stored in Australian-produced wood-based panels (2021–22)

Product type	**Production (thousand m^{-3})**	**Average C content (kgC m^{-3})**	**Total carbon stored (ktC)**
Plywood	191	285	54.4
Particleboard	1148	310	355.9
MDF	665	330	219.5
Total	2004		629.8

At EoL, decomposition of EWPs is very low under Australian landfill conditions. Controlled reactor studies report carbon losses typically below 2 %, with an average dissimilated-organic-carbon factor (DOCf) of 1.3 % [104]. The most recent Australia-wide carbon balance assessment of forests and wood products reports consistent results: only about 1.4 % of landfilled wood carbon is lost to the atmosphere, with a total of approximately 148 Mt C stored across wood products in use and in disposal [105]. These findings confirm that landfill functions as a long-term reservoir and that disposal primarily affects the timing rather than the magnitude of re-emissions. Consequently, the carbon embodied in panels serves as a medium-term reservoir, whose mitigation relevance arises from delayed release and opportunities for reuse or recycling.

Overall, the results presented in Tables 7 and 8 clarify both the magnitude and expected duration of carbon retention associated with Australia's wood-based panel production. The estimated inflow of ~0.63 Mt C during 2021–22 represents only 3.1–5.6% of total HWPs carbon, but it is a quantifiable and verifiable flow within the broader carbon cycle. When interpreted through the lifespan and EoL parameters in Table 7, this inflow defines the boundary conditions for potential long-term retention under current manufacturing and waste-management practices. Rather than simulating full stock dynamics, the analysis identifies a consistent structural gap between forest-level carbon inflows and the fraction embodied in durable wood building products. Recognising and quantifying this imbalance transforms a static inventory into a diagnostic indicator of Australia's capacity for durable biogenic carbon storage.

3.3.4 Lifecycle carbon tracking: from forest carbon to embodied building emissions

Evaluating the mitigation potential of timber in buildings requires tracing how biogenic carbon moves across the forest–wood–building chain, from forest resources and harvesting systems (Section 3.3.1), through sequestration and harvest-related emissions (Section 3.3.2), and into downstream wood building products (Section 3.3.3). This integrated perspective clarifies how carbon stored in forests is transferred, transformed, and ultimately released or retained across product lifespans and EoL pathways.

Figure 8 illustrates this lifecycle structure following EN 15978, from forest growth and harvesting (A1), through manufacturing (A2–A3), construction logistics and installation (A4–A5), use-phase service life (B1–B7), and EoL management (C1–C4), with Module D capturing credits from reuse, recovery, and recycling beyond the system boundary. By explicitly aligning forest and building system boundaries, this approach avoids overstating mitigation potential by excluding flows unrelated to construction uses [106].

Figure 8. Conceptual schematic of lifecycle carbon stages relevant to timber-based construction, aligned with EN 15978 [106]

Conventional reporting typically applies the IPCC Global Warming Potential 100 (GWP100) metric, which aggregates all greenhouse gas fluxes over a 100-year horizon [107]. While this supports comparability across sectors, it masks the temporal dynamics of wood products, where service life, recycling, and landfill decay determine when carbon is released. Recent work has demonstrated that dynamic approaches can capture these temporal shifts more accurately. For example, temporally differentiated models show that long-lived products such as CLT or LVL can retain carbon for several decades, providing near-term mitigation benefits compared to shorter-lived MDF or general-purpose particleboard [108,109]. Frameworks such as Dynamic Carbon Uptake in the Built Environment (D-CUBE) further demonstrate how delayed emissions alter warming profiles, underscoring the value of combining conventional GWP100 with time-adjusted indicators such as the Temporary Averaged Warming Potential [109,110].

Applying these principles in the Australian context requires acknowledging both methodological opportunities and structural limitations. The Full Carbon Accounting Model (FullCAM), Australia's official tool for GHG inventory reporting, provides reliable estimates of carbon stocks and fluxes in forests and plantations but does not extend to product-level allocation or building-sector storage [111]. ABARES production statistics report sawnwood and panel volumes yet are primarily production/trade-focused and rarely disaggregate construction-specific end uses. Large sawmills and panel mills are enumerated in national surveys, whereas smaller processors and joineries are under-represented, consistent with FAO's long-standing observation that secondary and small-scale production is often underreported where institutional data flows are fragmented [112]. Industry sources also indicate that demand for EWPs is expanding faster than the granularity of official datasets, creating blind spots for lifecycle analysis [113]. Within these constraints, the quantified panel inflow established in Section 3.3.3 provides an empirical bridge between forest-level carbon removal and material-level storage in buildings, connecting verified production data to measurable retention in wood-based panels and offering a transparent reference point for integrating national carbon accounting with lifecycle-based building assessments.

Integrating dynamic accounting principles with such conservative boundaries supports a transparent and reproducible framework for lifecycle carbon tracking. By linking verified production data with empirically derived lifespan classes, recycling and landfill shares, and temporal emission factors, this approach clarifies how timing influences apparent mitigation outcomes without extrapolating beyond available evidence. Although the present analysis does not conduct dynamic simulations, the established baseline enables future studies to test how measurable changes□ such as extending panel service life or adjusting observed recycling rates□ could affect cumulative carbon retention and release. Recognising and bounding uncertainties in underreported flows from small mills and secondary processors enhances the transparency and interpretive reliability of national carbon accounting efforts.

In sum, while precise national accounts of timber-related carbon flows remain constrained by data gaps, this study applies a conservative, product-specific boundary combined with dynamic-accounting principles to demonstrate how biogenic carbon can be credibly integrated into building-sector decarbonisation assessments in Australia. This approach does not resolve all uncertainties, but it clarifies what can currently be determined, highlights key gaps, and lays a foundation for future refinement of carbon accounting methods.

4. Discussion

4.1 From forests to buildings: clarifying the supply chain

The results reveal a structural paradox within Australia's timber–carbon system. Nationally, HWPs store an estimated 167 Mt C, yet only a small, traceable fraction of these flows, mainly durable WBPs, can be confidently linked to long-term storage in the built environment. Paradoxically, it is this limited and verifiable subset that provides the most reliable evidence for connecting forest carbon removal with material-level retention. This finding raises a central question: why does such a small proportion of the total material stream provide the strongest credibility for national carbon accounting? The discussion that follows interprets this question in light of

Australia’s current data structures and identifies opportunities for more integrated, time-resolved reporting.

Timber and wood products present quantification challenges that are structural as well as biophysical. Unlike steel or concrete, which are produced in highly centralised industrial systems, timber manufacturing occurs across a dispersed network of large mills and smaller regional processors [114]. This decentralisation supports regional economies but complicates the generation of consistent datasets and the application of lifecycle methods that assume uniform production conditions. National statistics capture harvest volumes and major product categories but rarely trace end-use destinations with enough resolution to distinguish short-lived outputs (e.g., packaging, paper) from long-lived WBPs. As demonstrated in Section 3.3, this lack of end-use disaggregation limits the precision of downstream carbon storage estimates and obscures timber’s contribution to construction-related mitigation [115].

At the same time, the broader significance of timber within Australia’s bioeconomy remains clear. Wood products constitute a substantial and renewable carbon stock; wood and other biomass supplied about 14 % of national renewable energy consumption in 2023–24; and the value of wood imports continues to exceed exports, reflecting reliance on processed imports and a trade orientation towards lower-value intermediates [116]. These indicators collectively highlight both the national importance of timber and the opportunity to strengthen domestic manufacturing and traceability. Improved end-use resolution, particularly in identifying durable, construction-relevant WBPs, would enable a more accurate representation of these benefits in carbon accounting and policy frameworks.

Analysis of national carbon inventories, lifecycle databases, and sectoral reporting frameworks shows that persistent data fragmentation, rather than outright scarcity, remains the primary constraint on Australia’s timber carbon accounting system. Recent initiatives demonstrate significant progress. The *Timber Industry Sector Framework for Setting Carbon-Emission Targets* developed a sector-specific methodology for calculating Scope 1–3 emissions and incorporating biogenic carbon, enabling manufacturers such as Timberlink to obtain Science Based Targets (SBTi) approval [117]. In parallel, the FWPA updated and harmonised cradle-to-gate datasets for sawnwood, plywood, LVL, MDF, and particleboard, providing a verified national baseline for embodied carbon disclosure and benchmarking [103]. Together these projects confirm that credible, product-level carbon data already exist and can be expanded through coordinated reporting.

The central challenge, therefore, lies not in the complete absence of data but in achieving consistency and continuity across existing reporting systems. While initiatives such as FWPA’s Life Cycle Inventory (LCI) and Environmental Product Declarations (EPDs) projects have improved product-level coverage, these datasets remain methodologically isolated from broader national frameworks such as FullCAM and ABARES production statistics. Establishing clear linkages between forest carbon models, manufacturing inventories, and product-use data would provide a more coherent view of biogenic carbon flows, particularly for long-lived building products. This integration represents a necessary step toward more transparent and time-resolved carbon accounting, but remains constrained by current data availability and institutional boundaries.

A potential concern is that focusing on well-documented, long-lived products may underestimate the broader mitigation potential of timber. This is a valid consideration; however, prioritising verifiable product classes is a methodological necessity rather than an exclusionary choice. Long-lived WBPs may represent the best-documented product category, with relatively consistent lifespan data, traceable end-use allocation, and quantifiable carbon-storage parameters available at the national level. Defining this boundary explicitly does not preclude future inclusion of other categories as data quality improves; rather, it provides a transparent and reproducible baseline for expanding coverage in a controlled and scientifically defensible way. Such boundary clarity enhances the credibility of timber-related carbon accounting and supports the gradual development of adaptive, evidence-based reporting systems aligned with international transparency frameworks.

4.2 Bridging forestry and construction in carbon accounting

The paradox identified in Section 4.1 highlights the methodological need to re-link existing systems so that biogenic carbon can be traced continuously from forest growth to building use. Achieving such continuity does not require the creation of new datasets but rather the re-alignment of established models and reporting frameworks, ensuring that forest-level sequestration and building-level storage are represented within a consistent temporal logic.

Such fragmentation in carbon accounting is not unique to Australia but reflects a broader structural limitation in how forestry and construction systems are typically modelled. In the Australian context, comprehensive forest-level models such as FullCAM quantify carbon stocks and fluxes with high temporal precision, while ABARES production statistics capture harvest volumes and trade flows. Yet these systems operate independently and terminate before product-level allocation, creating a discontinuity between upstream sequestration reporting and downstream LCAs. Consequently, the portion of biogenic carbon retained in WBPs remains underrepresented in national inventories.

This disjunction is increasingly recognised in cross-regional modelling studies that integrate forest carbon dynamics with product-use systems. As Maierhofer et al. (2024) highlight, opportunity costs of forest carbon and substitution benefits of wood products are often assessed separately, preventing identification of the "climate optimum" where forest management and material use are jointly optimised [118]. The lack of temporal and system continuity limits understanding of how much biogenic carbon is ultimately retained in long-lived construction materials and how delayed emissions influence their mitigation potential.

Recent methodological developments demonstrate practical ways to address this gap. The Carbon Budget Model Framework for Harvested Wood Products (CBMF-HWP) integrates product pools with decay and substitution functions, enabling temporally explicit estimates of carbon storage and avoided emissions [119]. Dynamic LCA approaches similarly distinguish between short- and long-lived products, showing how delayed emissions and recycling pathways alter mitigation outcomes compared with static GWP100 metrics. Frameworks such as D-CUBE [110], demonstrate the feasibility of linking sequestration dynamics with product use, while Maierhofer et al. (2024) highlight the importance of jointly optimising forest carbon and substitution pathways. Together, these advances point to a desirable pathway for Australia: extending established forest-level models into downstream product and building applications.

Progress toward such integration can proceed incrementally. First, existing inventory tools could incorporate allocation modules for construction-related categories (e.g. sawnwood, plywood, LVL, CLT), supported where feasible by targeted surveys or anonymised industry reporting to approximate flows from small mills and secondary processors that remain underrepresented in national statistics. Second, dynamic product models such as CBMF-HWP and D-CUBE should be calibrated using verified Australian data on species composition, conversion efficiencies, and service life distributions. Third, outputs from these models could be linked with downstream disclosure mechanisms, including EPDs, Building Information Modelling (BIM), and Scope 3 inventories, to establish continuity between forest monitoring and building sector carbon reporting, consistent with the Enhanced Transparency Framework under the Paris Agreement.

In sum, while Australia's current systems effectively quantify carbon dynamics in forests, they do not yet capture carbon flows into the building sector. Integrating dynamic, product-specific models within national reporting structures would bridge this divide, improve temporal coherence across the forest–wood–building chain, and strengthen the scientific basis for recognising timber's role in long-term climate mitigation.

4.3 Integrating timber into national climate and construction policy

The international recognition of timber as a climate-responsive material, reinforced at COP28, highlights the importance of aligning forestry, construction, and climate policy. In Australia, current efforts remain fragmented, with state-led initiatives such as Victoria's prefabrication schemes and NSW’s design incentives advancing timber adoption, but without national coordination across forestry, housing, climate, and supply chain development [120,121]. This limits the sector’s capacity to deliver structural transformation.

At the federal level, two recent policy shifts create stronger foundations for integration. First, Australia has legislated mandatory climate-related financial disclosures, beginning for large entities with financial years starting on or after 1 January 2025. These reports, aligned with the International Sustainability Standards Board (ISSB) and the Australian Sustainability Reporting Standards (ASRS), require firms to disclose climate-related financial risks and opportunities, including those associated with embodied emissions in supply chains [122]. Second, the Environmentally Sustainable Procurement (ESP) Policy, effective from 1 July 2024, applies to Commonwealth funded construction projects above AUD 7.5 million and will expand to selected goods categories in 2025. The ESP requires tenderers to address environmental sustainability, providing a mechanism to favour materials with lower embodied emissions, such as EWPs [123,124].

These developments mark what is possible under existing regulation: embodied carbon is entering both disclosure and procurement frameworks, offering indirect but powerful pathways to support timber uptake. On their own, however, these instruments risk reinforcing fragmentation unless coordinated under a national strategy. What is desirable is to ensure these mechanisms capture the full lifecycle benefits of timber, including both its lower embodied emissions and its role in long-term carbon storage. At present, federal instruments do not explicitly mandate timber, but they create conditions in which it can compete more effectively against emissions-intensive materials. Importantly, the NCC operates as a performance-based framework. While it permits timber use through DTS provisions, it cannot directly mandate specific materials. This means that indirect levers such as procurement standards and embodied-carbon disclosure remain the more viable pathways for mainstreaming timber in Australia.

We recommend three steps to strengthen integration. First, align procurement rules with lifecycle carbon metrics that recognise durable storage in construction-grade timber, not only upfront embodied emissions. Second, ensure disclosure frameworks (under ASRS) require consistent treatment of material substitution effects, enabling comparability across timber, concrete, and steel. Third, coordinate state and federal initiatives under a national timber strategy that links supply side forestry policies with demand-side housing and infrastructure targets. Together, these measures would bridge the current policy fragmentation and establish timber as a credible component of Australia’s climate and construction agenda.

4.4 International insights: lessons from Canada

Canada's *Mass Timber: Roadmap to Net-Zero Carbon Construction* provides one of the most comprehensive examples of a national timber strategy, though its context differs in forest type, land tenure, and governance [51]. The roadmap sets a clear target: to increase the share of mass timber in new non-residential buildings from <1% to 10% by 2030. This target is supported by quantified measures, including the delivery of 10–15 demonstration buildings each year, the establishment or upgrading of five manufacturing facilities, and CAD 2.4 billion in combined federal and provincial funding. These commitments link industrial capacity, housing demand, and climate objectives in a coordinated framework.

What distinguishes the Canadian roadmap is its integration of lifecycle carbon accounting into policy mechanisms. Rather than addressing forest carbon and construction separately, it connects upstream forest resources with downstream embodied carbon metrics, a linkage directly relevant to the accounting fragmentation identified in our study. This framing positions mass timber not only as a building material but as part of climate targets, procurement frameworks, and housing strategies. The roadmap also emphasises performance-based policies (e.g., procurement standards, embodied carbon benchmarks) rather than prescriptive building code mandates, maintaining regulatory flexibility while driving structural change.

For Australia, three transferable lessons stand out. First, measurable national targets with accountability mechanisms can support clearer planning for both industry and government. Second, embedding lifecycle accounting frameworks across forestry, housing, and climate policy would help bridge the current disjunction between forest carbon reporting and construction sector assessments. Third, aligning industry development (e.g., domestic EWP manufacturing facilities) with climate objectives would ensure that investment flows strengthen both supply security and emissions reduction. Together, these lessons suggest that an adapted, Canadian roadmap could help address Australia's fragmented policy landscape and provide a transparent, credible pathway for timber's contribution to national decarbonisation.

5. Conclusions

This study examined how commitments made at COP28 intersect with Australia's forest–wood–building chain, clarifying the extent to which timber can contribute to building sector decarbonisation under current supply, accounting, and policy conditions. The analysis highlights five main findings:

(1): Softwood plantations underpin the measurable carbon link between forests and buildings. Australia's softwood plantations supply most construction-related products and thus represent the primary resource base for long-term carbon retention. Plantation hardwoods and native forests currently contribute marginally under existing infrastructure and policy settings. Focusing on this subset clarifies the portion of HWPs that genuinely supports enduring storage in the built environment.

(2): Limited domestic processing capacity constrains the effective use of biogenic carbon. The analysis indicates that Australia’s ongoing reliance on imported sawnwood and panels reflects restricted domestic capacity for value-added production. This imbalance between resource availability and processing output limits the ability to retain biogenic carbon within national material flows. Expanding plantation resources and strengthening processing infrastructure could therefore enhance the sector’s role in long-term carbon retention.

(3): Quantified biogenic carbon inflows establish an empirical basis for temporal analysis. The estimated inflow of approximately 0.63 Mt C (≈ 2.3 Mt CO_2eq) embodied in 2021–22 wood-based-panel production represents a small but traceable share of total HWPs carbon. This quantified and verifiable flow links forest-level carbon removal with downstream storage in products and defines the empirical boundary conditions needed for future time-resolved carbon modelling.

(4): Fragmented accounting frameworks remain a key methodological limitation. Current national systems, including FullCAM and ABARES statistics, quantify forest carbon stocks and HWPs volumes but do not yet track carbon beyond the point of production or allocate flows to specific end uses. Establishing linkages between these datasets and dynamic models, adapted to Australian conditions, could close this gap by enabling consistent, time-resolved tracking of biogenic carbon from forest growth through to building use and EoL.

(5) Policy alignment is essential for credible carbon reporting and practical uptake. Recent instruments, including the ASRS and ESP Policy, create emerging opportunities to recognise the carbon value of timber products. Embedding verified product-level data into these frameworks could improve transparency, comparability, and policy coherence across forestry, manufacturing, and construction sectors.

In conclusion, this study provides new insights into how measurable biogenic carbon flows can be linked across the forest–wood–building chain using existing data and dynamic accounting logic. By clarifying where verifiable carbon storage occurs and how it can be represented in national systems, the research offers a scientifically grounded foundation for more transparent reporting, more consistent policy design, and more informed decarbonisation strategies in the built environment.

Declarations

Author contributions statement

Yi Qian: Conceptualisation, Data Curation, Formal analysis, Methodology, Writing - Original Draft, Writing - Review & Editing, **Isuri Amarasinghe:** Data Curation, Writing - Original Draft, **Harshani Dissanayake:** Resources, Writing - Original Draft**, Sasindu Samarawickrama:** Data Curation, Visualisation, Writing - Original Draft, **Tharaka Gunawardena:** Conceptualisation, Project administration, Supervision, **Priyan Mendis:** Supervision, Funding acquisition, **Lu Aye:** Supervision, Writing - review & editing.

Ethics, consent to participate, and consent to publish declarations

This study did not involve human participants, animals, or personal data. Therefore, ethics approval and consent to participate and publish are not applicable.

Competing interests

The authors declare no conflicts of interest related to this study.

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Clinical trial

Not applicable.

Data availability statement

No datasets were generated or analysed during the current study. Data sharing is not applicable.

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