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Advancing Timber for the Future Built Environment

ENGINEERED WOOD PANELS FROM RECYCLED TIMBER: A SUSTAINABLE SOLUTION FOR AUSTRALIAN CONSTRUCTION

Isuri Tamura Amarasinghe[1], Tharaka Gunawardena, Priyan Mendis

ABSTRACT: The rising demand for sustainable construction materials has highlighted the potential of engineered wood panels made from recycled timber. This study explores the benefits and feasibility of utilising these panels in Australia, a nation committed to reducing its carbon footprint and promoting sustainable practices and embracing a circular economy. Data collected from various sources regarding the demand for engineered wood panels, and the availability of recycled wood were analysed, and detailed statistical analysis and forecasting were performed, demonstrating that these panels offer a viable solution to both the increasing wood waste problem and the wood supply shortage for wood panel production in the country. Despite some challenges, these panels provide significant benefits in addressing the gap between the production and consumption of engineered wood panels in the country. The paper concludes with recommendations to enhance the adoption of engineered wood panels, highlighting their crucial role in advancing Australia's sustainable construction initiatives.

KEYWORDS: recycled timber, sustainable construction, wood waste management, wood panels, circular economy

1 – INTRODUCTION

The construction industry is moving towards sustainable alternatives to building materials as a response to global carbon emissions, resource depletion and waste generation. Among these alternatives, engineered wood panels made from recycled timber have emerged as a promising solution [1]. By repurposing timber waste, these panels not only mitigate the increasing landfill accumulation, but also reduce the reliance on virgin wood resources for the panel production, aligning with global sustainability goals and the principals of circular economy.

Following the recent emphasis at the 28th Conference of the Parties (COP28) on increasing the use of sustainable managed timber products in buildings to decarbonise the construction sector, countries have pledged to adopt global approaches toward reducing greenhouse gas (GHG) emissions and increasing the amount of carbon stored in buildings. Seventeen countries, accounting 26% of global timber production, have committed to expanding the use of sustainable timber products, highlighting the growing recognition of wood's role in a circular and low-carbon economy [2]. Engineered wood panels from recycled timber present an innovative pathway to fulfil these commitments while simultaneously managing timber waste effectively.

Australia, a nation facing timber supply shortages and with an increasing commitment to reducing its carbon footprint, presents a unique opportunity for adopting this innovative material. The country generates over 2.4 million tonnes of wood waste annually, yet only a small fraction is recycled, with the rest contributing to landfill burden [3]. Simultaneously, the rising demand for engineered wood panels in construction increases the strain on existing timber supplies. These challenges, coupled with Australia's commitment to reducing its carbon footprint under international agreements, underscore the necessity of sustainable material solutions. The transition toward engineered wood panels from recycled timber not only addresses environmental challenges but also fosters innovation and resilience within the construction industry.

Despite the environmental and economic potential of engineered wood panels from recycled timber, their adoption in Australia remains limited. Reasons for this limited use include uncertainty regarding the availability and quality of recycled timber, cost considerations, and insufficient awareness within the construction sector. To address these gaps, this paper investigates the feasibility of recycled timber panels as a sustainable construction material, exploring their environmental, economic, and technical advantages. By using statistical analysis and forecasting, as well as scenario analysis, the study aims to provide actionable insights for enhancing the adoption of these materials within Australia's construction industry.

2 – BACKGROUND

Engineered wood panels are defined as sheet-like products made by combining fibres, veneers, and particles, bonded with adhesives and pressed under heat

[1] Isuri Amarasinghe, Department of Infrastructure Engineering, The University of Melbourne, Victoria, Australia, iamarasinghe@student.unimelb.edu.au

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[4]. These can be classified into several diverse types according to parameters such as particle size, density, and manufacturing process type. Among these panels, plywood, medium-density fibreboard (MDF), particleboard, and oriented strand board (OSB) are most commonly used as building materials and furniture applications, due to their higher density, strength, and durability [5].

Due to its popularity, the global wood-based panel consumption is projected to exceed 500 million m³ by 2030 [6]. This, along with a severe timber supply shortage, the construction industry faces significant challenges and environmental concerns. The incorporation of waste wood in the production of engineered wood panels has become a potential area of interest, and has proved to be a sustainable solution, improving the resource efficiency of wood and aligning with the circular economy concept. Waste wood, including offcuts, veneers, chips, and sawdust, can be effectively processed to fabricate engineered wood panels with notable mechanical and physical strength [7].

Australia's construction industry, one of the largest consumers of wood-based products, generates significant timber waste annually through construction, demolition, and commercial activities. However, much of this waste ends up in landfills, exacerbating resource depletion and environmental issues. Figure 1 illustrates the timber waste generated in Australia by category for 2022–2023 and highlights the substantial contribution of wood waste.

Recycling timber waste into engineered wood panels offers an innovative solution to reduce waste and conserve forest resources. By leveraging these materials, Australia has the potential to address its timber supply shortage and reduce its environmental footprint.

2.1 MERTIS OF USING RECYCLED TIMBER IN ENGINEERED WOOD PANELS

Engineered wood panels from recycled timber offer substantial environmental, economic and technical benefits. One of the key advantages is the reduction in landfill waste and the associated environmental impact. By diverting wood waste from landfills and repurposing it into engineered wood panels, the industry can contribute to a circular economy, reducing deforestation and the demand for virgin timber.

From an economic perspective, incorporating recycled timber into engineered wood panels can lower production costs and enhance supply chain resilience. The growing demand for engineered wood panels has led to increased reliance on imported products due to declining domestic production. By utilizing locally available recycled timber, manufacturers can reduce dependence on imported materials, stabilize pricing, and create new market opportunities for sustainable building products. [8].

While case studies have demonstrated the feasibility of using recycled timber in composite panels and furniture applications [9], the potential for widespread adoption within the construction industry remains largely untapped. Australia's abundant timber waste sources, advancements in recycling technology, and increased industry awareness of environmental sustainability create opportunities for growth in this sector.

2.2 CURRENT LANDSCAPE OF RECYCLED WOOD USE IN AUSTRALIA

Despite these advantages, several challenges hinder the widespread adoption of recycled timber in engineered wood panels. One of the primary obstacles is the limited infrastructure for wood waste collection, sorting, and processing. A significant portion of timber waste in Australia still ends up in landfills due to inadequate recovery systems and inefficient waste segregation at demolition and construction sites. Without a well-developed supply chain for collecting and processing recycled timber, manufacturers face difficulties in sourcing high-quality raw materials consistently. Additionally, contamination of wood waste with adhesives, paints, or preservatives can complicate recycling efforts, requiring additional processing steps that increase costs and limit scalability.

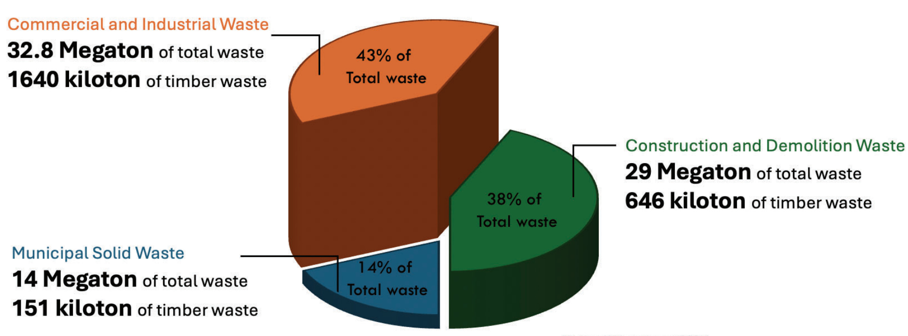

Figure 1. Waste generation in Australia by category and wood waste contribution for the year 2022-2023

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While efforts to repurpose timber waste are increasing, much of it is still used for mulch, fuel, or animal bedding rather than high-value applications such as engineered wood panels [10]. Additionally, the use of primary and secondary wood residues for particleboard production is primarily limited to small-scale manufacturing, restricting its broader impact on waste reduction and sustainability goals.

Moreover, the lack of industry standards and certification frameworks for recycled wood panels poses a barrier to wider adoption. Addressing these challenges will require investment in recycling infrastructure, policy incentives, and industry collaboration to enhance the viability and acceptance of recycled timber in engineered wood manufacturing.

By exploring the current landscape of timber waste availability and engineered wood panel demand in Australia, it is possible to evaluate the feasibility of using recycled timber in panel production. By addressing these aspects, the study aims to provide a comprehensive understanding of how recycled timber can advance Australia's sustainable construction goals and contribute to a circular economy.

3 – METHODOLOGY

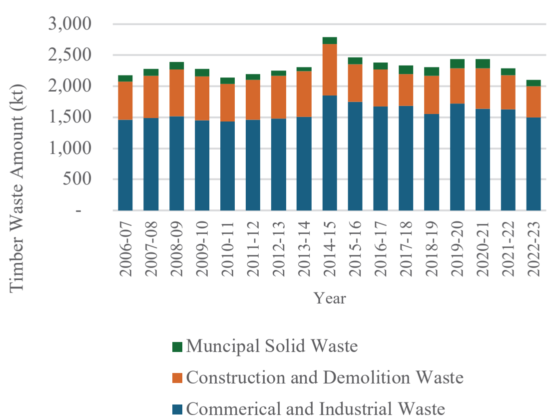
In order to understand the viability of engineered wood panels from recycled timber in Australia, a statistical analysis and forecasting study was conducted for two main datasets by using data gathered from national reports. First, the availability and potential supply of waste wood were evaluated by looking at the data on national timber waste generation quantities, source of timber waste and recycling rates. Next, a market demand analysis of engineered wood panels is carried out to quantify the potential market size for panels and to identify the economic opportunities and feasibility by identifying the market trend.

3.1 TIMBER WASTE GENERATION AND RECYCLING

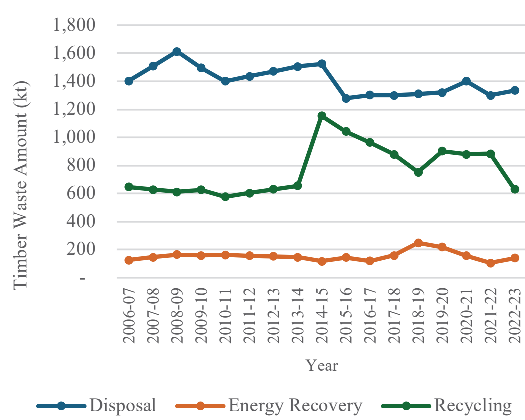
Data obtained from the national waste and resource recovery database for the period from 2006-2007 to 2022-2023 prepared by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) [3] were filtered out each year to those related to timber. The data contained information on the jurisdiction of the waste, source stream, management and fate of the waste for each year. The three main sources of timber waste were commercial and industrial waste (C&I), construction and demolition waste (C&D), and municipal solid waste (MSW). The timber waste was then sent for disposal, for recycling or for energy recovery.

The data were then broken down by source and the final fate of the timber waste, and linear regression was used to estimate the missing data for the fiscal years 2007-2008, 2011-2012 and 2012-2013. The recycling rate, disposal rate and energy recovery rate were calculated as percentages of total timber waste generated for each year. Figure 2 shows the timber waste management information for the period 2007-2023 with 2(a) illustrating a stacked bar chart of the annual timber waste generated from the three sources, C&I, C&D and MSW, and 2(b) showing the line graph of the timber waste management methods; disposal, energy recovery and recycling.

Next a forecast analysis was carried out by predicting the wood waste generation for the period 2024-2035 using an Auto-Regression Integrated Moving Average (ARIMA) model. The ARIMA model predicts future values by analysing patterns in the residuals of linear regression models and combining these with forecasted values. It is widely recognized as an effective tool for statistical prediction [11].



(a)



(b)

Figure 2: Timber waste generation and management trends in Australia from 2006-2023 (a) Annual timber waste generation (b) Annual waste management

The Augmented Dickey-Fuller (ADF) test was conducted to check the stationarity of the dataset (if the mean and variance are constant over time), and once found it was not stationary, the data was transformed using differencing to stabilize the mean of the time series. After ensuring stationarity, the ARIMA model parameters p (autoregressive term), d (degree of differencing), and q (moving average term) were identified through an analysis of the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots. Based on these, a model was selected and fitted separately to the wood waste generation and recycled amounts.

The model was trained on historical data from 2007 to 2023, and forecasts were generated for the period 2024-2035. The results provided insights into future trends in wood waste generation and recycling.

This was followed by an overall analysis on the wood waste management according to the jurisdiction. Data on the recycling rate, disposal rate and energy recovery rate of the timber waste for each state annually were considered and analysed

3.2 ENGINEERED WOOD PANEL DEMAND

For the engineered wood panel demand analysis, the current market demand was analysed using the data obtained from the Australian forest and wood product statistics prepared by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) [12]. The annual production and annual apparent consumption of engineered wood products, mainly plywood, particleboard and medium density fibreboard, were filtered out for the period from 2006-2007 to 2022-2023. Figure 3 illustrates the annual production and the annual apparent consumption of engineered wood products in Australia during this time period.

Similar to the previous analysis, linear regression was used to estimate the missing data, and an ARIMA model was used to predict the future demand of these engineered wood panels, for the period 2024-2035.

3.3 FEASIBILITY ANALYSIS OF ENGINEERED WOOD PANELS FROM RECLYCLED TIMBER

To evaluate the feasibility of using engineered wood panels made from recycled timber to meet national demand, a scenario analysis was conducted. This analysis utilized data on wood waste availability, panel production capacity, and consumption levels to determine the potential contribution of recycled timber to bridging the supply gap. The percentage of forecasted wood waste required for recycling into engineered wood panels was calculated to ensure self-sufficiency in domestic production and address the projected shortfall in supply.

The forecasted production and consumption amounts were converted into weights by multiplying the values given in cubic meters, by the industry average density of the engineered panels. These weights were then compared with the forecasted timber waste disposal amounts, with and assumption that 70% of the disposed wood is suitable for the panel production. This approach provided a realistic assessment of the resource potential [7].

The following three scenarios were considered in this analysis;

Scenario 1 – 10% of the forecasted wood waste disposal is utilized for engineered wood panel production.

Scenario 2 – An incremental increase in the use of wood waste for engineered wood panel production, starting at 10% in 2024 and increasing to 30% by 2035

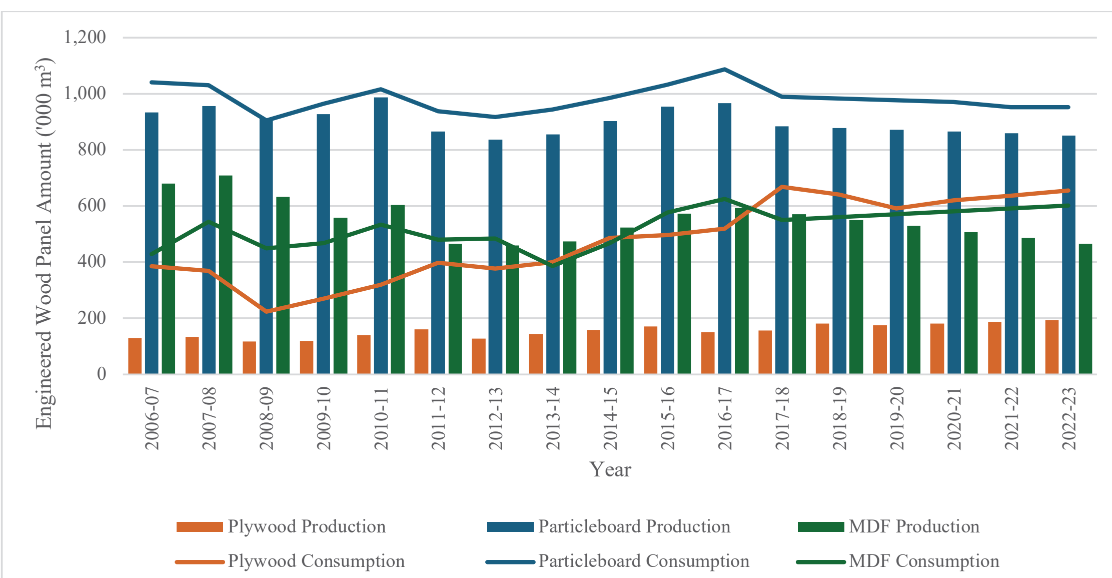


Figure 3: Annual production and annual apparent consumption of engineered wood panels in Australia (2007-2023)

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Scenario 3 - By 2035, 75% of the forecasted gap in production is filled by engineered wood panels made from recycled timber.

For each scenario, the potential production from recycled wood was compared to the forecasted annual consumption of the three main types of engineered wood panels.

5 – RESULTS

The analysis and forecasting indicate that by 2035, Australia is projected to generate over 2.5 million tonnes of timber waste annually, marking a 16% increase from 2023 levels. Approximately 1.4 million tonnes of timber are disposed of in landfills each year across the nation, and there is very limited use of the energy recovery from timber waste at the moment. Currently, in average only 31.1% of timber waste is recycled, and a data from 2006-2023 shows a decrease trend in the recycling rate from a nationwide perspective. Table 1 shows the comparison between the three timber waste management methods in amounts and rates between the fiscal year 2006-2007 and 2022-2023.

Moreover, the analysis of wood waste management data from 2022-2023 by geographical location indicates that Victoria, New South Wales, South Australia, and Queensland show the highest potential for adopting this sustainable material, as these regions already recycle a significant percentage of their wood waste. Figure 4 highlights the differences in waste management practices across Australia, showing how states vary in waste generation and their approaches to disposal, recycling, and energy recovery.

Table 1: Timber waste management method rates comparison

Timber waste management method	2007		2023		Change	
	Amount (kt)	***Rate (%)***	***Amount (kt)***	***Rate (%)***	***Amount (kt)***	***Rate (%)***
Disposal	1,404.0	64.5	1,335.9	63.4	↓68.1	↓1.1
Energy Recovery	126.6	5.8	140.9	6.7	↑14.3	↑0.9
Recycling	646.4	29.7	630.8	29.9	↓15.6	↑0.2

The demand for engineered wood products shows an increasing trend, with panel consumption steadily rising, showing an 16% increase in overall apparent consumption in 2022-2023 compared to that of 2006-2007. This value is forecasted to further rise in the next decade, with a precited consumption of 2.5 million m^3 by 2035, a 34% increase compared to 2006-2007.

Although particleboard consumption and production have remained relatively stable, overall, domestic production is failing to meet rising demand, reinforcing the need for alternative solutions such as increased use of recycled timber in engineered wood panel production to reduce import dependency and enhance sustainability.

Table 2 compares the consumption and production amounts of engineered wood panels, plywood, particleboard and MSD, in Australia between the fiscal year 2006-2007 and 2022-2023. Plywood and MDF demand have increased significantly, but domestic production has not kept pace, leading to a significant deficit which is more apparent in 2022-2023 compared to 2006-2007 values.

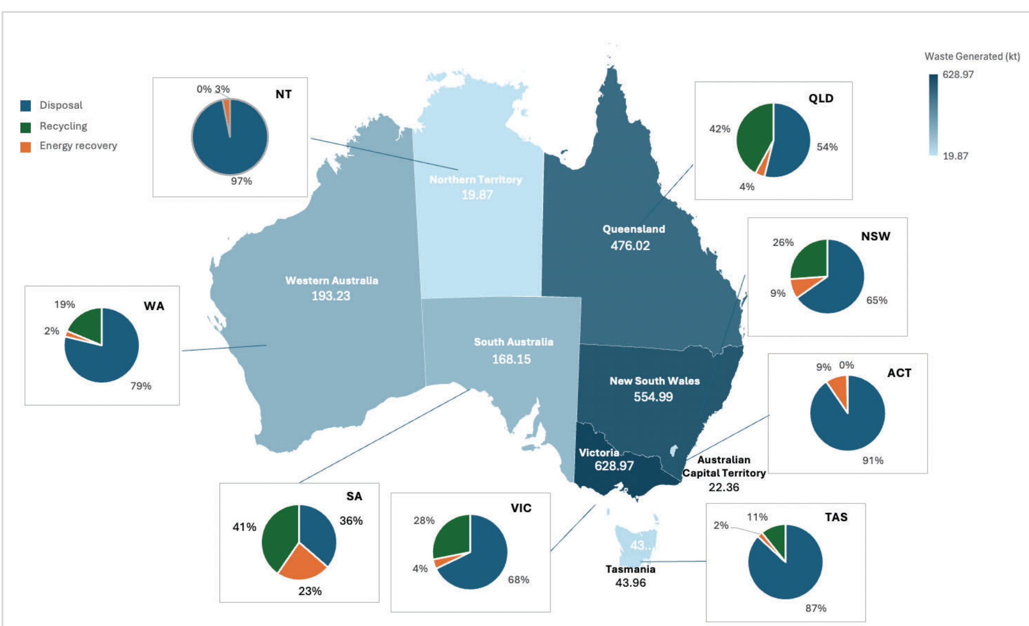

Figure 4: Wood waste management data analysed for the year 2022-2023 according to geographical location

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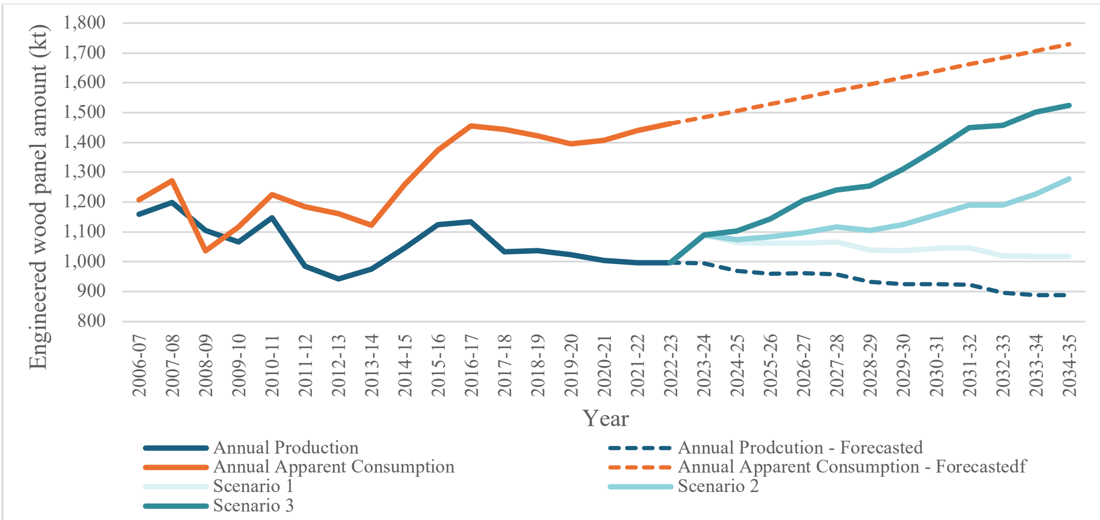

Figure 5: Forecasted production and consumption trends of engineered wood panels using recycled timber in Australia

Although particleboard consumption and production have remained relatively stable, overall, domestic production is failing to meet rising demand, reinforcing the need for alternative solutions such as increased use of recycled timber in engineered wood panel production to reduce import dependency and enhance sustainability.

Table 2: Engineered wood panel production and consumption comparison

Engineered Wood Panel	2006-2007		2022-2023		Change	
	Consumption (' 000 m^3)	Production (' 000 m^3)	Consumption (' 000 m^3)	Production (' 000 m^3)	Consumption	Production
Plywood	386	130	683	190	↑76.9%	↑46.2%
Particleboard	1041	933	1036	909	↓0.5%	↓2.6%
MDF	429	680	586	418	↑36.6%	↓38.6%

Therefore, utilizing recycled timber in panel production presents a highly viable option to meet this demand while reducing reliance on imports. This is further proved by the scenario analysis, where in Scenario 1, even if 10% of the disposed engineered wood is utilised for wood panel production, it is possible to meet up to 15% of the engineered wood panel deficit by 2035.

Similarly, in Scenario 2, if 30% of disposed wood waste is utilized for panel production by 2035, it would be possible to meet 46% of the gap between production and apparent consumption. To achieve Scenario 3, where 75% of the gap is closed using panels produced from recycled wood waste, the percentage of disposed wood waste utilized would need to increase to 49% by 2035, raising the national wood waste recycling rate to 72% - a significant improvement compared to the forecasted rate of 46%. This highlights the transformative potential of scaling up wood waste recycling for sustainable engineered wood panel production. Figure 5 illustrates these different scenarios of utilizing wood waste for engineered wood panel production and how it can affect the overall gap between the panel consumption and production.

6 – CONCLUSIONS AND RECOMMENDATIONS

The findings from this study have the potential to contribute significantly to the sustainable timber construction and wood production. It highlights the growing demand for engineered wood panels in Australia, with consumption expected to rise over 2.5 million m^3 over the next decade. However, domestic production has failed to keep pace, leading to an increasing reliance on imports. At the same time, timber waste generation continues to rise, with a large portion still being disposed of in landfills and only a small fraction being recycled. This presents both a challenge and an opportunity—by improving timber waste recycling, Australia can reduce imports, minimize waste, and enhance sustainability in the construction sector.

The data forecasting and scenario analysis conducted in this study demonstrates that even modest increases in the use of recycled timber for panel production can significantly reduce the supply gap. Achieving higher recycling rates could not only improve resource efficiency but also contribute to a circular economy in engineered wood manufacturing. However, realizing this potential requires investment in recycling infrastructure, policy interventions, and stronger industry engagement.

To address these challenges, it is recommended that Australia expand its wood waste processing capacity, implement policies to incentivize recycled panel production, and integrate sustainability-driven market strategies. Encouraging the use of recycled wood panels in construction, setting clearer recycling targets, and

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supporting innovation in engineered wood manufacturing will be essential. By scaling up timber waste recycling, Australia can move towards a more self-sufficient and environmentally sustainable engineered wood panel industry.

7 – REFERENCES

[1] ABARES, *Australian forest and wood products statistics, March and June quarters 2022, ABARES series report, Canberra, November*. 2022. DOI: 10.25814/c34m-qk65.

[2] (FCLP), F.C.L.P., *World Leaders Double Down on Forest and Climate Action at the Start of COP 28*, I.L. Maldonado, Editor. 2023.

[3] The Department of Climate Change, E., the Environment and Water, *National waste and resource recovery report 2024*. 2025.

[4] Youngquist, J.A. *Wood-based Composites and Panel Products*. 1999.

[5] Norhazaedawati, B., SaifulAzry, S.O.A., Lee, S.H., and Ilyas, R.A., *4 - Wood-based panel industries*, in *Oil Palm Biomass for Composite Panels*, S.M. Sapuan, et al., Editors. 2022, Elsevier. p. 69-86.

[6] Food and Agriculture Organisation, *Forestry Production and Trade*. 2021. p. http://www.fao.org/faostat/en/#data/FO.

[7] Amarasinghe, I.T., Qian, Y., Gunawardena, T., Mendis, P., *Composite Panels from Wood Waste: A Detailed Review of Processes, Standards, and Applications.* Journal of Composites Science, 2024. **8**(10): p. 417.

[8] Suominen, T., Kunttu, J., Jasinevičius, G., Tuomasjukka, D., *Trade-offs in sustainability impacts of introducing cascade use of wood.* Scandinavian Journal of Forest Research, 2017. **32**(7): p. 588-597. DOI: 10.1080/02827581.2017.1342859.

[9] Gharehbaghi, K., Rahmani, F., and Paterno, D., *Adaptability of Materials in Green Buildings: Australian Case Studies and Review.* IOP Conference Series: Materials Science and Engineering, 2020. **829**: p. 012006. DOI: 10.1088/1757-899X/829/1/012006.

[10] Daian, G. and Ozarska, B., *Wood waste management practices and strategies to increase sustainability standards in the Australian wooden furniture manufacturing sector.* Journal of Cleaner Production, 2009. **17**(17): p. 1594-1602. DOI: https://doi.org/10.1016/j.jclepro.2009.07.008.

[11] Sharma, V., Ghosh, S., Mishra, V.N., and Kumar, P., *Spatio-temporal Variations and Forecast of PM2.5 concentration around selected Satellite Cities of Delhi, India using ARIMA model.* Physics and Chemistry of the Earth, Parts A/B/C, 2025. **138**: p. 103849. DOI: https://doi.org/10.1016/j.pce.2024.103849.

[12] Sciences, A.B.o.A.a.R.E.a., *Australian forest and wood products statistics,*. 2023: Canberra, Australia. DOI: 10.25814/pzh6-3w22.