building 4.0 crc

#37: AUSTRALIAN TIMBER FIBRE INSULATION SCOPING STUDY

FINAL REPORT – FOR PUBLICATION

ultimatewindows

HYNE TIMBER

THE UNIVERSITY OF MELBOURNE

Australian Government
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Disclaimer

1. EXECUTIVE SUMMARY

The Australian timber industry generates significant quantities of low grade by-products in the form of chips and sawdust through the manufacturing of sawn and mass timber products. Most problematic among these are the H2 and H3 treated products that are not currently re-purposed into other products. Additional to this timber waste stream are large amounts of other low to no value feedstock such as bark (currently exceeding 400,000 tonnes annually), single use timber pallets and other non-timber waste streams such as shredded plastic fibres.

These by-products have the potential to be manufactured into higher value fibre insulation products for the Australian market. Currently, no such products are locally manufactured in Australia, with importers servicing the Australian market. This presents an opportunity to divert considerable quantities of waste from landfill and produce a high performance, locally made, low carbon, natural fibre insulation product for the Australian domestic and commercial building industry.

This project investigated the techno-economic feasibility of establishing a timber insulation manufacturing facility in Australia. This report summarises outcomes from the key project objectives including: an outline of timber fibre insulation products and providers, existing relevant patents, application of timber fibre in construction, feedstock options, feedstock availability and costing, manufacturing and equipment requirements as well as an estimation of production cost.

This research identified a clear opportunity for timber fibre panel production in Australia. Future steps would likely involve industry partners performing a detailed business case for operations in Australia, including significant research work to investigate drier residue use to produce timber fibre insulation.

2. PROJECT OVERVIEW

2.1 Introduction

The insulation industry in Australia offers significant value by improving energy efficiency, reducing environmental impact, enhancing comfort and health, supporting the economy, and is integral to improving sustainable building practices. Demand for insulation is expected to increase with the 2022 National Construction Code (NCC) revisions mandating a minimum of 7 Star NatHERS targets for residential dwellings with most states and territories adopting the measures between 2023 and 2025. With the increasing focus on energy conservation and sustainability, demand for insulation is expected to grow, further reinforcing its value.

Australia's insulation industry encompasses a wide range of products, including insulation materials, installation services and associated equipment. According to reports and industry estimates, the Australian market was valued at AUD1–2 billion per year.[1] This value includes both residential and commercial sectors, considering new construction projects as well as retrofitting and insulation upgrades.

The Australian timber industry generates significant quantities of low grade by-products in the form of chips and sawdust through the manufacturing of sawn and mass timber products. Most problematic among these are the H2 and H3[2] treated products that are not currently re-purposed into other products. Treated waste timber poses environmental risks due to chemical contamination, health hazards, disposal challenges, recycling limitations, legal compliance requirements and the need for public awareness.

The presence of significant amounts of low-value timber waste, bark and single-use timber pallets in Australia presents an opportunity for the insulation industry. Manufacturing these by-products into high-value fibre insulation products locally can divert waste from landfills. This initiative can contribute to environmentally friendly, locally made, high-performance insulation products for the Australian domestic and commercial building industry.

Timber fibre insulation aligns well with global efforts to promote green building practices, reduce carbon footprint and mitigate climate change. This report focuses on the development of timber fibre insulation and highlights the following key advantages:

- Thermal performance: Timber fibre insulation offers excellent thermal resistance (R-value), enhancing energy efficiency in buildings. It helps to regulate indoor temperatures, reducing the need for artificial heating and cooling and lowering energy consumption and emissions.
- Moisture management and indoor air quality: Timber fibre insulation has hygroscopic properties, meaning it can absorb and release moisture, contributing to a healthy indoor environment. It helps manage humidity levels which can help to reduce condensation and mould.
- Acoustic performance: Timber fibre insulation provides good sound absorption properties, reducing noise transmission between rooms and from external sources
- Versatility and ease of installation: Timber fibre insulation products are versatile and can be used in various applications, including walls, roofs, floors, and ceilings. Panels or bats are lightweight and easy to handle.
- International market demand: The global market for sustainable and energy-efficient construction materials is growing rapidly. Timber fibre insulation aligns with this trend, making it an attractive choice for architects, builders, and developers worldwide.

[1] IBIS World Data 2022.
[2] See Table 7 for product definitions.

In summary, the timber fibre insulation industry is a growing one with significant value in sustainable building practices, improving energy efficiency, enhancing moisture management and indoor air quality, and providing acoustic benefits. Australia would benefit from the production of these insulation products which would not only reduce waste but also contribute to reducing greenhouse gas emissions.

2.2 Approach

This scoping study assesses the techno-economic feasibility and opportunities associated with creating a timber (and potentially other material) fibre insulation manufacturing facility in Australia. The project begins by summarising the types of timber fibre insulation products manufactured globally and available in Australia, focusing on performance specifications, dimensions, manufacturing methods and feedstock utilised. This initial investigation includes a patent search to determine what technological developments have been made for these products and their application to buildings. Based on the identified feedstock materials, we explored the availability and cost of these feedstocks in Australia. Then, we identified potential options for manufacturing, including the high-level machinery requirements. Finally, we performed a preliminary cost of production assessment to manufacture the timber fibre insulation in Australia and compared it with existing products in the marketplace.

2.3 Project aims and objectives

This research aims to:

(1) Investigate and summarise existing timber fibre insulation products in the global marketplace

(2) Summarise the use of timber fibre insulation applications in the Australian and global construction industry including a patent search

(3) Investigate the potential for different Australian feedstock materials that could be used to create timber fibre insulation and shortlist them based on feasibility

(4) Assess the potential availability and cost of the shortlisted feedstock in Australia

(5) Ascertain the high-level machinery requirements to manufacture timber fibre insulation products

(6) Assess the cost of production for timber fibre insulation products in Australia and compare them with existing insulation products.

This research aligns with Building 4.0 CRC's '3.1.7: High Performance Materials and Systems Implemented' milestone, which is about newly developed materials/systems used by partners, and implementation and usage feedback captured with focus on buildability, compliance, quality, cost, sustainability and performance.

3. OUTCOMES

3.1 Timber fibre insulation product summary

This section outlines extensive research carried out to (1) summarise different classes and applications of timber fibre insulation in the Australian and global construction industry, and (2) identify timber fibre insulation products in the global marketplace as well as in Australia.

Different types of timber fibre insulation in the market include flexible and rigid board insulation. Table 1 summarises typical classes and applications of timber fibre insulation products.

Table 1 Typical classes of timber fibre insulation products in the market

Typical classes	Application	Density	Production method	Materials
Flexible insulation 	Friction mounted between studs/rafters	50 kg/m^3	Dry production	Wood fibres, polyamide (binding fibre), ammonium phosphate (flame retardant)
Rigid board insulation 	External walls	180 kg/m^3	Dry and wet production	Wood fibres, PMDI glue (isocyanate), paraffin wax, latex
Rigid board insulation 	Walls and roof	140 kg/m^3	Dry and wet production	Wood fibres, PMDI glue (isocyanate), paraffin wax, latex
Rigid board insulation 	Below floor screed (also roof and walls)	140 kg/m^3	Dry and wet production	Wood fibres, PMDI glue (isocyanate), paraffin wax, latex

Figure 1 Typical insulation classes for timber fibre insulation (Pavatex – Switzerland (2021))

Table 2 provides the list of timber fibre insulation product providers available in the global marketplace as well as in Australia.

Table 2 List of timber fibre insulation products providers

Company	Manufactured location	Available in the Australian market
GUTEX	Germany	Yes
STEICO	Germany	Yes
PAVATEX	Switzerland	Yes
UdiSYSTEMS	Germany	Yes
BetonWood	Italy	No
MSL	Canada	No
Hunton	Europe	No

Tables 3 and 4 provide technical specifications along with the cost associated with each product provided by GUTEX and Steico suppliers in Australia.

Table 3 Technical specifications and cost of 3 GUTEX products (GUTEX 2022)

Classes	Length (mm)	Width (mm)	Thickness (mm)	Edge	Thermal conductivity λD (W/mK)	Price per m² (AUD)	Applications
GUTEX Thermoflex	1350	575	30-240	Square	0.036	$12-$60	Between-stud insulation in timber frame, post and beam interior and exterior wall structures Between-rafter insulation Ceiling insulation Partitions/drywall structures
GUTEX Thermowall Durio	1800	600	70	Tongue & Groove	0.04	$39	Specially designed and manufactured for the GUTEX Durio facade system
GUTEX Thermosafe-homogen	1200	625	30–240	Square	0.04	$10–$87	Universal insulating board with homogenous cross-section

Table 4 Technical specifications and cost of 3 Steico products (Insulate Naturally Supplier in Australia, access August 2022)

Classes	Length (mm)	Width (mm)	Thickness (mm)	Edge	Thermal Conductivity λD (W/mK)	Price per m² (AUD)	Applications
Steico Universal	2230	600	22–60	Tongue & Groove	0.048	$24–$48	External walls / Above roof rafters
Steico FLEX036	1220	575	40–240	Square	0.036	$48	Between studs/rafters / floor joists/ceiling area
Steico BASE	1150	595	20–100	Square	0.048	$22–$46	Perfect for heavy duty dry and wet screed construction

3.2 Timber fibre insulation comparison with other insulation materials

3.2.1 Thermal conductivity

Figure 2 compares thermal conductivity for timber fibre insulation with ~~all~~ other common insulation materials. It demonstrates timber fibre insulation products sit near the middle range, with only some of the high density products not showing good thermal conductivity.

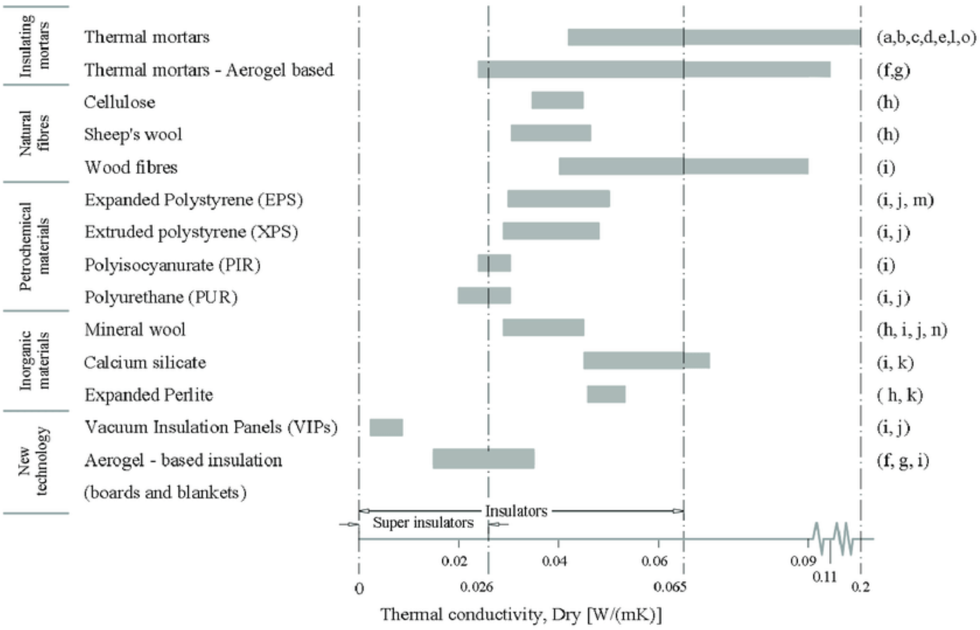

Figure 2 Thermal conductivity of timber fibre insulation compared to all the other insulation materials (Posani M, Veiga R. 2021)

3.2.2 Moisture

Timber fibre insulation is more resistant to moisture than the other insulation materials. For example, when a **fibre**glass batting gets wet, the R-value falls, the product gets heavy and packs down, and takes a long time to dry out. By contrast, wood fibreboards can absorb up to 15% of their weight in moisture without losing their insulation capacity[3]. When the air is dry, the moisture diffuses out of the product. The ability for water to escape and pass through the assembly creates a safer, more resilient wall assembly that is much less susceptible to mould formation.

3.2.3 Cost

Figures 3, 4 and 5 show the cost comparisons between different insulation products in Australia. Figure 3 shows the ceiling insulation cost comparison for R=4.0 (common minimum NCC requirements for new Australian homes). Timber fibre insulation products are considerably more expensive than glasswool and polyester, but less costly that rockwool and expanded polystyrene insulation (EPS).

[3] Gutex (2021) http://gutex.it/en/experience-gutex/

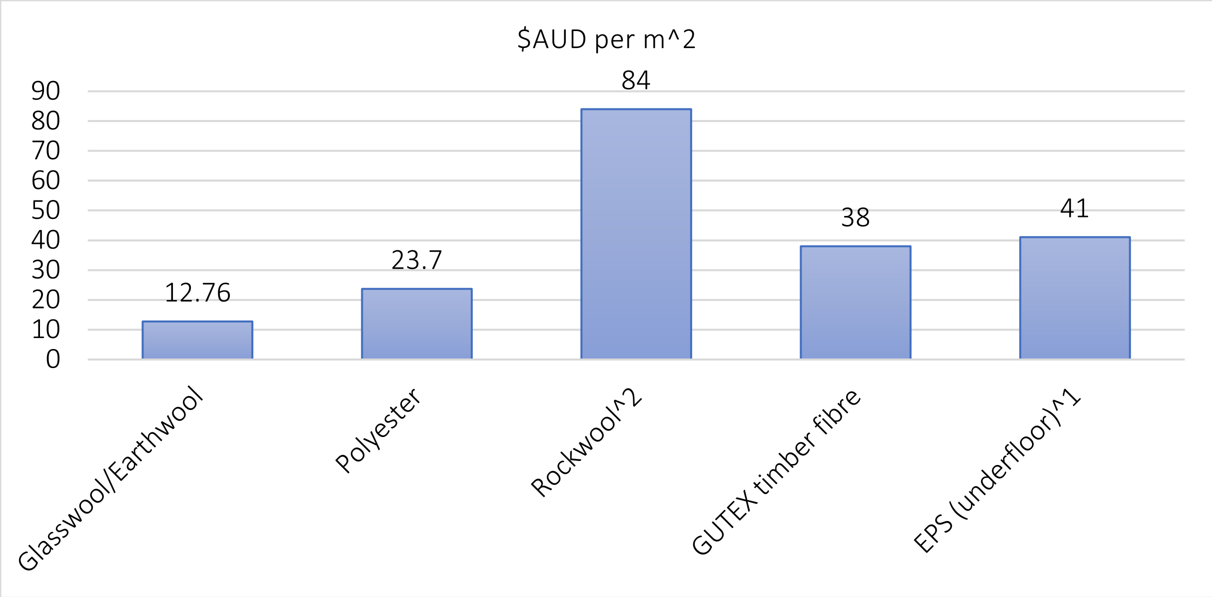

Figure 3 Ceiling insulation cost comparison for R=4.0 in Australia (adjusted from Pricewise Insulation August 2022)

^1 – For reference only (not used for walls) – estimated with two underfloor panels to meet R 4.0 value
^2 – Estimated based on two R 2.0 batts to meet R 4.0

Figure 4 shows the wall insulation (between studs) cost comparison for R=2.0 (also a common minimum NCC requirement for new homes). Timber fibre insulation products are more expensive than glasswool, polyester and EPS, but cheaper that rockwool.

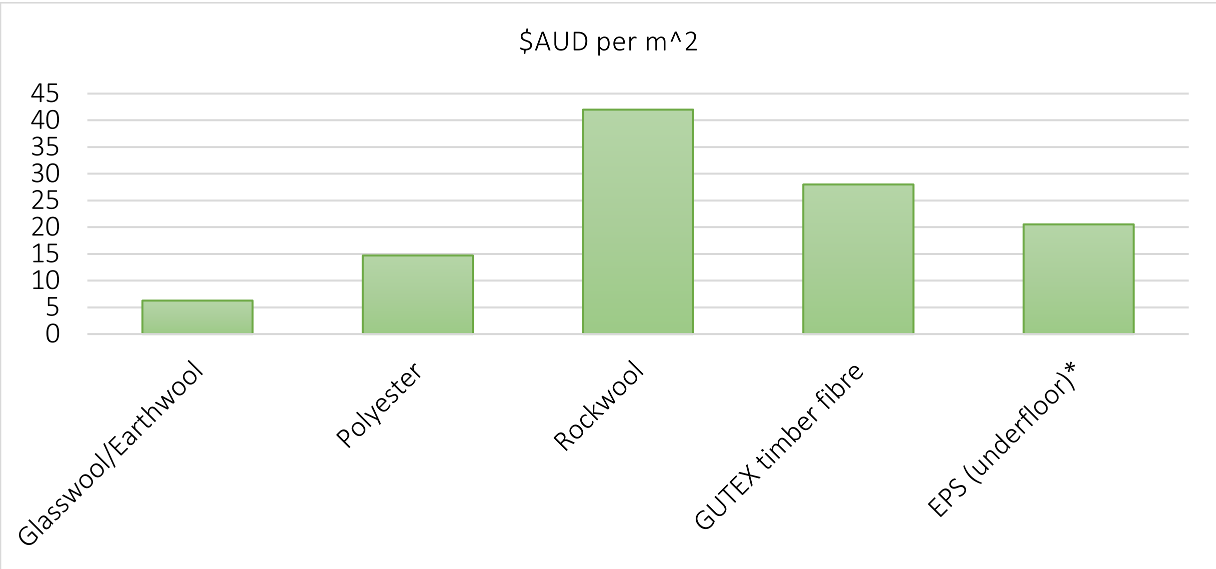

Figure 4 Wall insulation (between studs) cost comparison for R=2.0 in Australia (adjusted from Pricewise Insulation, and Cross-Laminated Timber, access August 2022)

Figure 5 shows the wall insulation rigid panels (the most common timber fibre insulation boards in Australia) cost comparison.

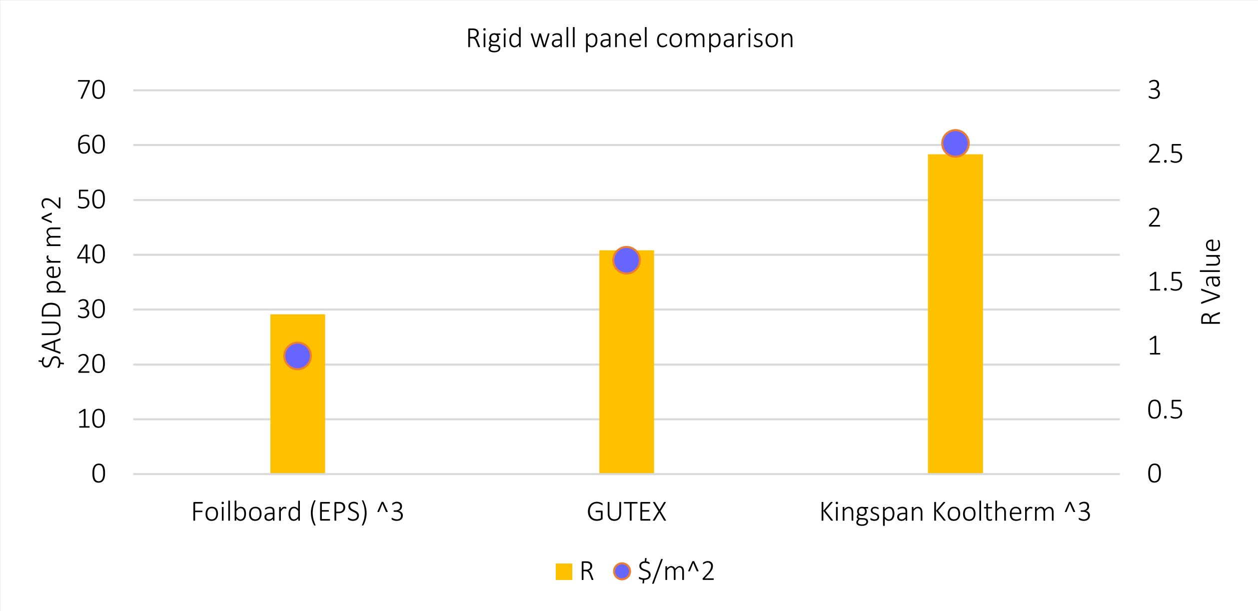

Figure 5 Wall insulation (rigid panel) cost comparison in Australia (adjusted from Pricewise Insulation August 2022 & Kingspan 2022)

^3 – Includes foil facing which depending upon build-up adds to system R value.

3.2.4 Other considerations

Other benefits of timber fibre insulation compared with all the other common insulation materials are listed below:

- Support and sagging is not an issue.
- Cutting to shape does not produce irritating fibres.
- It produces fewer eye, skin and lung irritation hazards than glass-based insulation products.
- It has acoustic benefits due to relatively high density.
- It produces clear sustainability benefits from using a waste product stream.
- It is naturally fire resistant, due to charring with the addition of aluminium oxide to enhance self-extinguish characteristics.
- Existing lead times for timber fibre insulation are 6+ months.
- It has low primary energy use and embodied CO_2 for production.
- It is biodegradable at end of life (or can be used for energy recovery).

3.3 Feedstock high-level analysis

We conducted a high-level feedstock analysis, assessing the residues from Hyne timber against key priorities, quantities and values. Table 5 shows a range of details, including value and quantities, about 6 different residue categories, provided by both Ultimate Windows and Hyne Timber.

Table 5 Residue relative market value and relative quantity available in Australia

Waste stream	Residue value	Quantity
Treated timber sawdust and offcut (no glue)	Negative (paid to dispose)	Small
Timber pallets	Negative (paid to dispose)	Very large
Mass timber offcuts (with glue)	Negative (paid to dispose)	Low
Bark	Low	Medium
Bark bulk	Medium	Medium
Green sawdust and chips	Medium	Very large
Seasoned but untreated sawdust	Medium	Medium

Green: Greatest advantage to use in timber fibre insulation.
Blue: Medium advantage.
Orange: Lowest Advantage.

3.4 From wood chips to wood fibre insulation

Wood fibre insulation is manufactured in 2 primary methods: wet production and dry production as summarised below:

3.4.1 Wet production

The wet process for manufacturing fibre insulation boards comprises the following steps (STEICO, access July 2022):

- processing the raw timber to form wood chips
- heating the wood chips under steam pressure
- defibrating the wood chips in the refiner
- mixing the fibres with water to form a fibrous paste
- possibly adding requisite additives (depending on product)
- shaping the insulating board by pressing
- cutting the insulating board to length
- drying the boards (160°C–200°C)
- gluing (if multiple laminates adhered together)
- cutting and profiling
- stacking, packing.

Maximum sheet thicknesses are around 25 mm. Thicker sections are built up by gluing together sheets with white glue (STEICO, access July 2022).

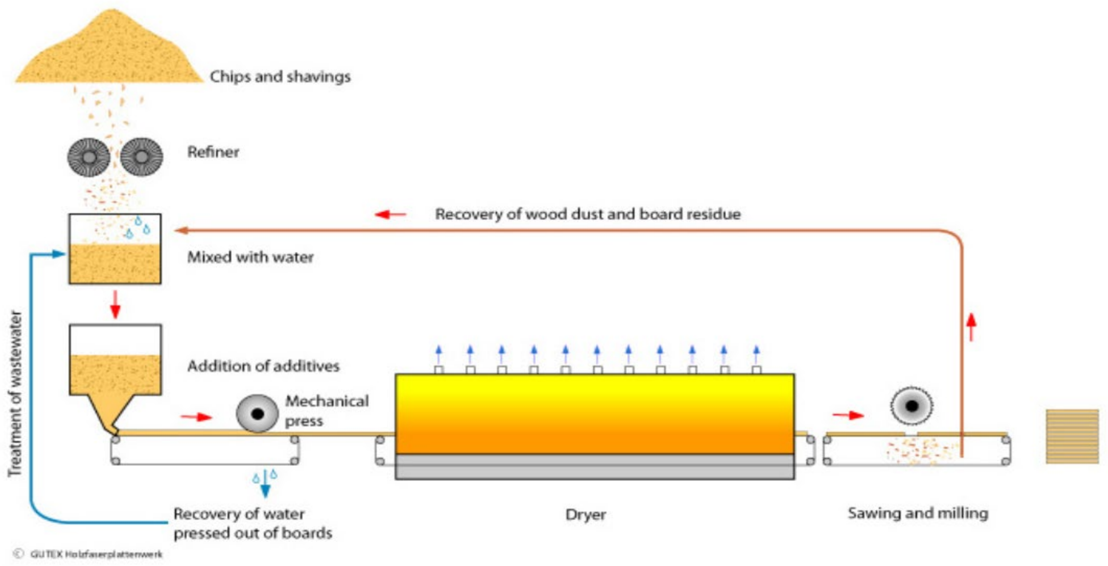

Figure 6 The wet process for manufacturing STEICO wood fibre insulation boards (STEICO, access July 2022)

3.4.2 Dry production

The dry process for manufacturing fibre insulation boards comprises the following steps (STEICO, access July 2022):

- Chips and shavings are retrieved as waste from other timber manufacturing processes.
- The fibres are sprayed with paraffin.
- The sprayed fibres are dried using warm air.
- The fibres are sprayed with polyurethane resin as a binder.
- The fibre mats are placed in a unit where the resin is cured and hardened through exposure to a mixture of air and water vapour.

The dry process produces single-ply boards up to around 240 mm in thickness.

Dry process advantages:

- Homogeneous composition (single-ply)
- Up to 240 mm thick
- Improved dimensional accuracy
- Increased tensile strength with relatively low density
- Requires 40% less energy
- 94–96 % wood composition

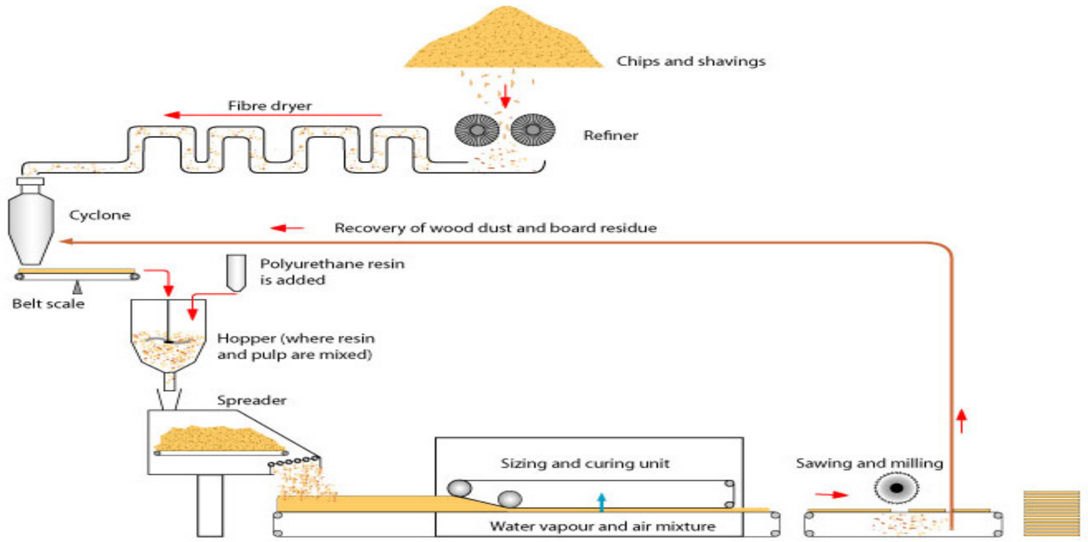

Figure 7 The dry process for manufacturing STEICO wood fibre insulation boards (STEICO, access July 2022)

3.5 Literature review on the laboratory scale of timber fibre insulation boards

We reviewed literature, including both journal articles and patents, on timber fibre insulation boards production in laboratory scale. Table 6 summarises the main findings of one patent and 3 journal articles.

Table 6 Literature review summary

Study	Feedstocks	Fibre preparation	Final product outcome	Scale
Wood-fibre heat-insulating material and method for the production thereof (patent) (2009)	- 100% wood chips from outer tree bark of thin timbers and old timbers (2–5 mm) - Binders	Wet and semi-wet method	Thickness: 50 mm Thermal conductivity: 0.038 to 0.040 W/mK	Lab scale
Investigation of thermal insulation panels made of black locust tree bark (2017)	- 100% the black locust tree bark - Urea-formaldehyde (UF) based resin	Chopped (1–13 mm), dried, pressed, conditioned	Thickness: 10, 20, 30, 40 mm Thermal conductivity: 0.0645 to 0.0665 W/mK	Lab scale
Production and characterisation of wood-fibre insulation boards (WFIB) from hardwood fibres and fibre blends (2021)	- 80% hardwood (European ash, European beech, and silver birch) - 20% softwood (Norway spruce or silver birch) - Adhesives	Dry process	Thickness: 40 mm Thermal conductivity: 0.038 W/mK	Lab scale
Wood waste as an alternative thermal insulation for buildings (2018)	- 100% Welsh sawmill (without addition of binders)	Sorted to 1–4 mm, dried, conditioned	Thickness: 60, 50, 40 mm Thermal conductivity: 0.048 to 0.055 W/mK	Lab scale

3.6 Treated timber waste considerations for panel production

3.6.1 Timber treatments level

There are different levels of treatment for plain sawn timber produced by Hyne (and other sawmills in Australia). Table 7 provides a list of timber treatments and hazard levels for treated timbers according to Australian Treated Pine (2022).

Table 7 List of timber treatments and hazard levels for treated timbers (Australian Treated Pine 2022).

Class of treatment	Description and application
H1	Designed to minimise the chances of an attack by insects and termites and best used in well-ventilated places.
H2	Designed to minimise the risk of an attack by insects and termites, and can be used in well-ventilated places but needs to be prevented from wetting.
H2F	Designed to minimise the risk of an attack by insects and termites, and must be protected from wetting, and is commonly used for framing in dry situations.
H2S	Protects timber against insects and termites, but it also allows for the timber to be subject to periodic moderate wetting.
H3	Suitable for use in applications where the wood is kept off the ground and exposed to weather conditions and periodic moderate wetting.
H3A	Designed to be applied to products that are predominantly in vertical exposed situations and intended to have a supplementary paint coat system that is maintained regularly.
H4	Suitable for use in applications where the timber is in contact with ground or is continually damp. H4 is designed to minimise the likelihood of attack by insects, including termites, and radical decay where a critically important end use is involved.
H5	A stronger level of protection, H5 is suitable for use in applications where the timber will come in contact with the ground or fresh water. Other than protecting against the likelihood of attack by insects, H5 also offers protection against extreme decay.
H6	As protection against the highest level of hazard, H6 is appropriate for applications where the timber will be in prolonged contact with sea water. H6 is designed to minimise the likelihood of attack by marine borers and extreme decay.

We developed a procedure to better highlight challenges associated with the use of varying degrees of treatment. Figure 8 details this process on how timber waste treatments can impact the production of insulation.

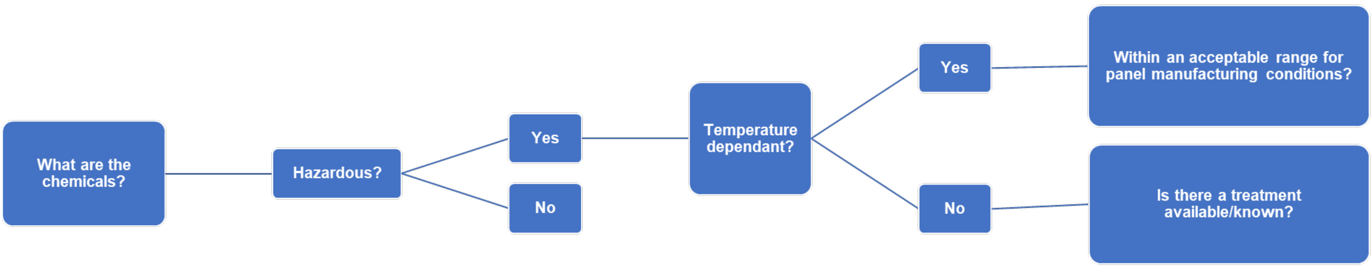

Figure 8 Approach on working with treated timber fibre panel

This process identified a range of additives with varying degrees of toxicity, principally of greater hazard at greater temperatures. Table 8 shows the different additives associated with different treated timber products and the relevant temperatures and potential safety concerns. All treatment levels require specific safeguards when heated beyond approximately 80ºC as required by timber fibre insulation production.

Table 8 Different additives of timber panels

Glulam Cahill	T2 Blue	T2 Red	T3 Green +
Tebuconazole (~4%) Melting Point: 102°C Emits toxic vapours of hydrogen chloride and nitrogen oxides when heated to decomposition. Cyproconazole (~1.5%) Melting point: 107°C Boiling point: >250°C When heated to decomposition it emits very toxic fumes of hydrogen chloride and nitrogen oxide	BIFENTHRIN (<0.01%) Melting point: 69°C Flash point: 165°C Easily ignited by heat Emits corrosive and/or toxic vapours of fluoride and chloride when heated to decomposition	BIFENTHRIN (<0.01%) See T2 Blue NAPHTHALENE (<0.05%) Melting point: 80°C Flash point: 80°C Vapour given off when heated is flammable and a dangerous fire hazard. Can release vapour to produce hazardous atmospheres with air under high ambient temperatures or under moderate heating.	Hyne Timber T3 Green+ Working Solution (<1%) Propiconazole Boiling point: 180°C Emits toxic vapours of nitrogen oxides and hydrogen chloride when heated to decomposition Tebuconazole See Glulam Cahill Permethrin Melting point: 34°C Boiling point: 200°C Inhalation may be harmful. Fire may produce irritating, corrosive and/or toxic gases.

3.7 Volume and pricing assessment for production in Australia

3.7.1 Volume assessment

Figure 9 shows the volume of residues provided by Hyne Timber. According to data, the majority of residues are pine chips followed by pine barks and pine shavings. Notably, these residues are not currently 'wasted' with almost all of these by-products currently being used for heating kilns, re-processing into laminates or, which is the case for bark residues, used for applications such as animal bedding and garden supplies. As previously discussed, the problematic treated waste (which has a disposal cost) makes up less than 1% of all residues.

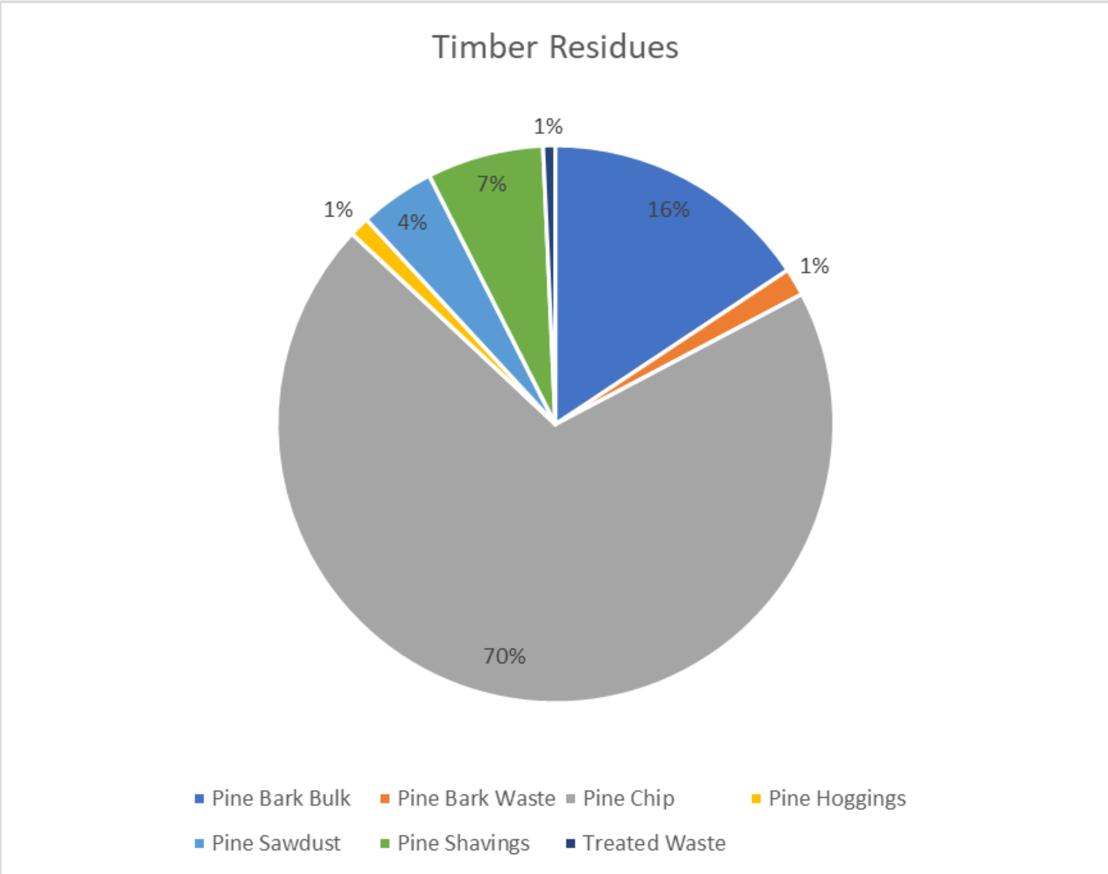

Figure 9 Relative volume of residues from Hyne Timber

3.7.2 Pricing assessment

We assessed the residue data to determine how much timber fibre insulation can be produced and the costs associated, using the following key assumptions:

- Mass assumes 'wet weight' with moisture content for green timber except for treated waste (conservative for recovery rate) with conservative moisture contents of ~120% for barks, 100% for green sawdust, 11% for shavings and 11% for treated waste. Pallets would have significant variation and have been assumed to have a moisture content of 30%.
- Final moisture content is ~11% for timber fibre products.
- An additional 5% of material is unrecoverable.

- Bulk and rigid panel insulations have densities as specified by GUTEX.
- Pallet calculations were extrapolated from Ultimate Windows and then extrapolated Australia wide using manufacturing indices – which resulted in an estimate of 400,000 tonnes of pallets disposed of annually in Australia.

Based on these assumptions, we performed some analysis on production volume of timber fibre insulation, feedstock prices, cost of raw material and demand of timber fibre insulation for Australian houses.

Figure 10 shows how much timber fibre insulation can be produced, both flexible and rigid board insulations. Because rigid board insulation is much denser than flexible insulation, the amount of rigid board insulation per m^2 is much less than flexible insulation.

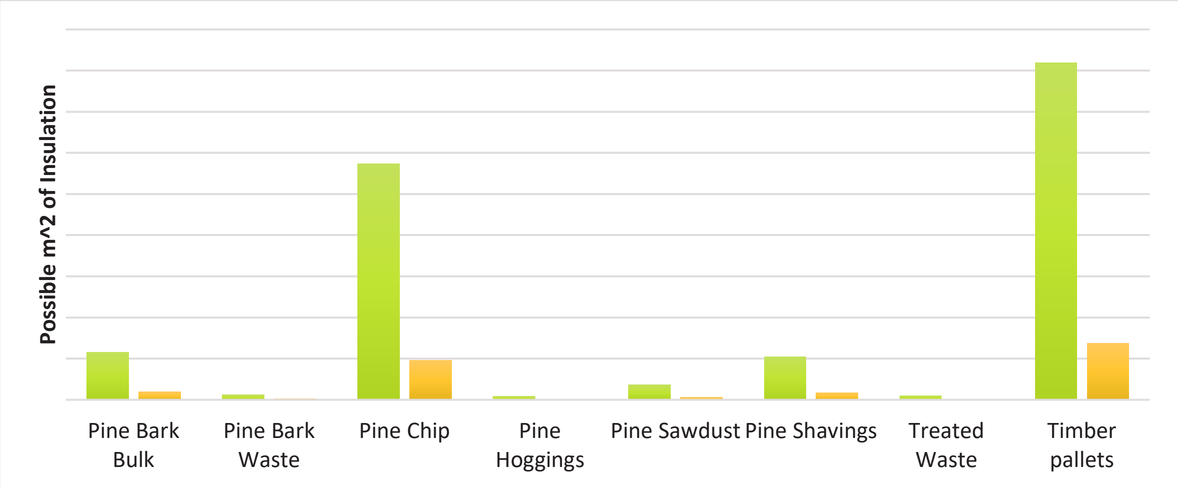

Figure 10 Australia wide production capacity for R 2.0 Bulk and R 1.75 Rigid Panel. Actual values removed for confidentiality.

Figure 11 shows the values of different feedstocks. According to data provided by Hyne, feedstock value varies relatively as shown in Figure 12 (actual values removed for confidentiality).

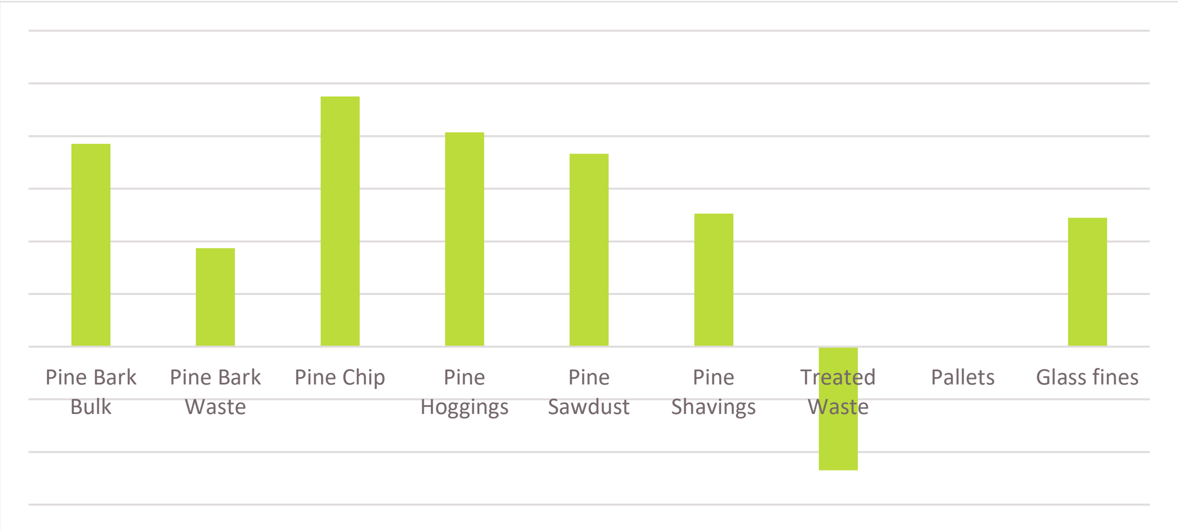

*Figure 11 Timber and glass residuals value *Sustainability Victoria 2014 – Prices vary significantly, and this value is indicative only.*

Once recovery is included, the costs for each potential feedstock increase considerably, principally due to moisture removal but also other losses in the production process as assumed above. This is presented in Figure 12.

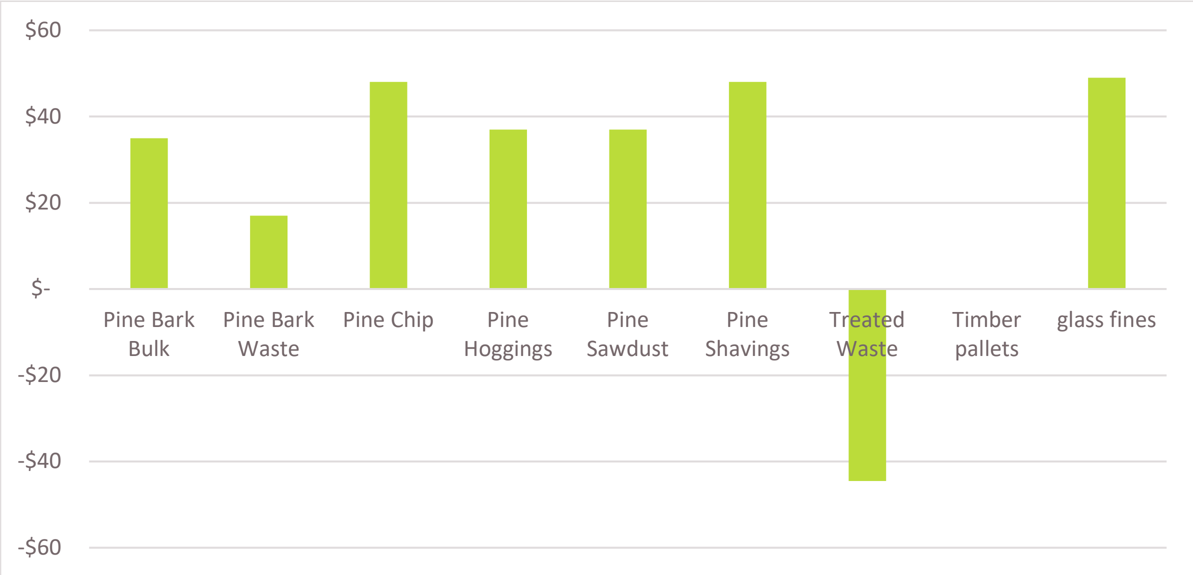

*Figure 12 Timber and glass residuals value after consideration of recovery rate. *Values removed for confidentiality. *Assumes recovery rate of 70% for pallets and 80% for glass fines.*

Finally, we assessed each residual to ascertain the quantity of timber fibre insulation that is required and hence the value of fibre used in each product class. Because flexible insulation is less dense, it uses less fibres and is therefore less expensive per m^2 than the rigid board products (Figure 13). We excluded timber pallets because the costs associated with collecting and transporting as well as acquiring them are uncertain at this stage. This figure highlights the low cost that feedstock contributes to the insulation with less than $0.4 per metre square of insulation. Compared with the least expensive glass fibre bat on the market (~$4.00 per metre square), this is around 10% of the retail value, indicating that the key costs associated with timber fibre production do not principally include the fibre feedstock.

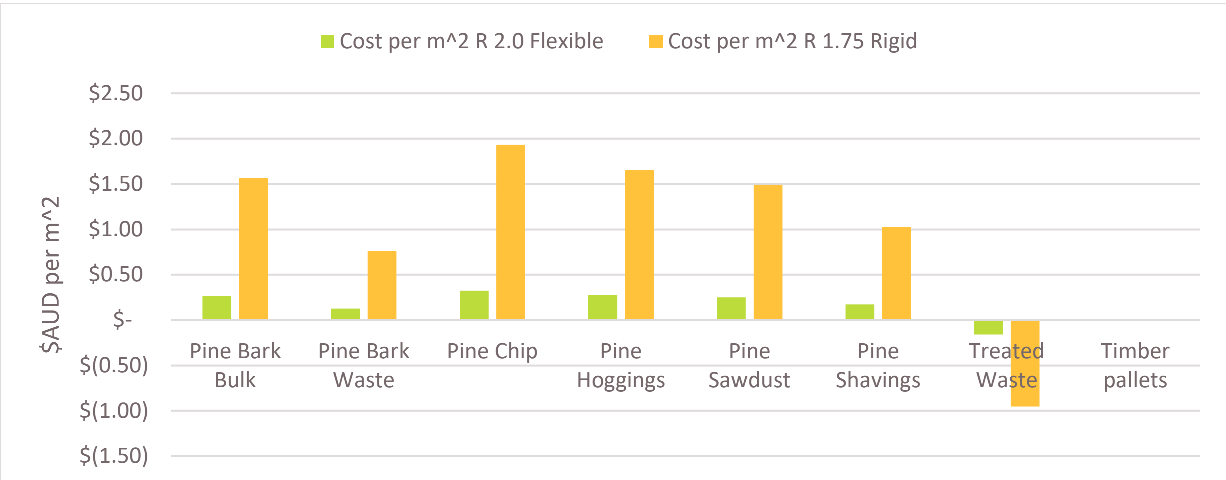

*Figure 13: Value of feedstock per m^2 in timber fibre panels *Glass fibre insulation is ~ 12.76 per m^2 and timber fibre retails for ~ $39 per m^2.*

The next step in the analysis was to assess the size of Australia's detached housing market (Table 9). For this high-level assessment, we estimated the insulation requirements of all new homes assuming R 2.0 as the NCC minimum insulation requirements for walls. This raw demand has been subsequently related back to the housing market demand shown in Table 9. According to data, we could use pine chips to supply wall insulation for every home built in Australia each year and still have some remaining (Figure 14).

Table 9 Detached housing market size in Australia (CSIRO AHD portal 2018)

Victoria new houses per year (no.)	Australia new houses per year (no.)	Average exterior wall area in a house (m^2)	Average floor area in a house (m^2)
50,000	150,000	190	180

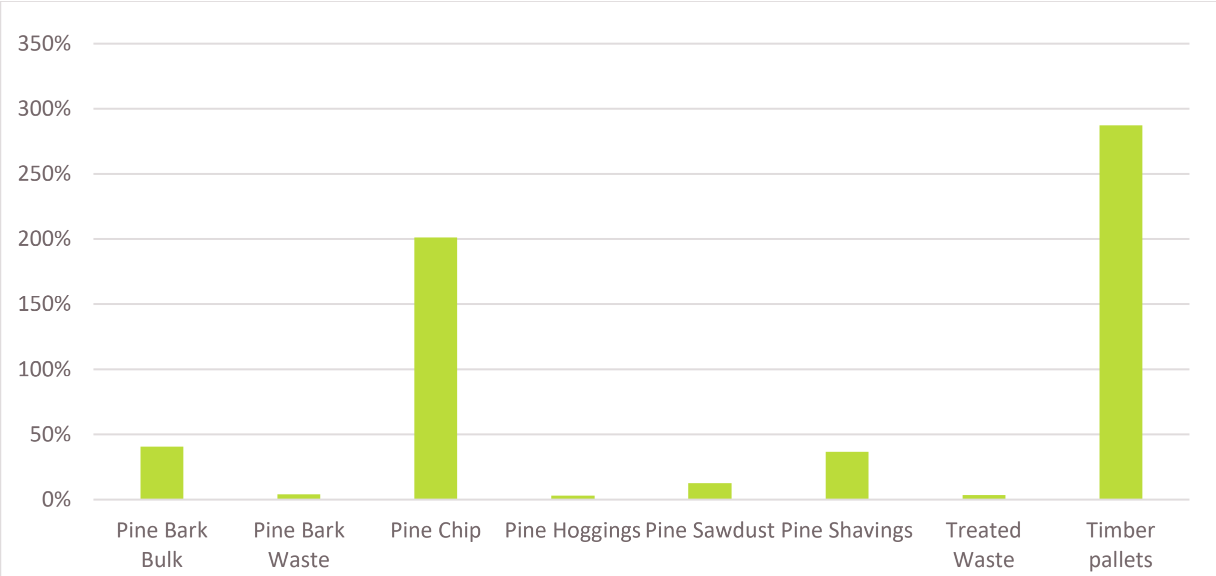

Figure 14 Percent of Australia's new houses that could have insulation supplied by each feedstock – walls only

Additional confidential details of the manufacturing facility have been provided to project stakeholders and are not included in this report. The key takeaway from this report and subsequent analysis is that there is clearly sufficient fibre available to produce timber fibre products and insulation for the Australian market. The following high-level analysis is summarised below for future reference.

A typical timber fibre manufacturing facility with the capacity of 1000–2000 m^3 of feedstock per day would supply between 8% and 15% of all the insulation requirements of new homes in Australia. The overall portion of the insulation market would be less than this figure with commercial and industrial insulation demands not included in the assessment.

According to other studies, timber fibre insulation represents approximately 7% of the total insulation market in Europe. Therefore, a manufacturer that can process around 1000 m^3 per day would likely suffice for the size of the Australian market. A facility of this size would consume between 10% and 25% of the pine chip residues that Hyne timber currently produces. If Hyne redirected treated waste residue then it would only be sufficient to produce approximately 300 m^3 of insulation product per day or approximately 2% of the Australian insulation market.

3.8 Timber fibre insulation production machinery manufacturers

Two of the world's leading manufacturers for timber fibre insulation production machineries are *Siempelkamp* and *Dieffenbacher*. All contact details and relevant information provided by these 2 manufacturers have been provided to industry partners.

According to the information provided by Siempelkamp, the typical dry process for wood fibre insulation boards included:

- chip preparation comparable to MDF process
- mechanical disintegration via refiner
- drying of fibres via flash tube dryer
- glue-dosing to the process via 'Dry Blow line DBL'
- conventional mazt forming according to MDF process
- mat heating and pressing with the Siempelkamp ContiTherm®–Principle
- quick curing of the glue in the calibration zone of the ContiTherm.

Additional supporting confidential quotations and information from Siempelkamp, including (exact cost and requirements) are provided to industry partners for their reference.

4. FUTURE RESEARCH PLANS

Analyses from this project demonstrate that there is both ample feedstock supply and insulation demand for timber fibre products. Therefore, there is an opportunity to convert low value feedstock to valuable timber fibre insulation boards, and a clear opportunity for timber fibre panel production in Australia. Additionally further research exploring the use of treated wood dust and safety concerns focusing on the differences between Cooper Chrome Arsenic CCA and alternative treatments. This would enable a better understanding of the chemicals used and associated risks to maximise potential applications of lower risk treatments.

Future steps would likely involve industry partners performing a detailed business case for operations in Australia, alongside carrying out significant research to investigate drier residue use to produce timber fibre insulation. Further research opportunities exist once the industry begins procuring plant and equipment to broaden the possible feedstock options and applying them to timber fibre insulation.

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