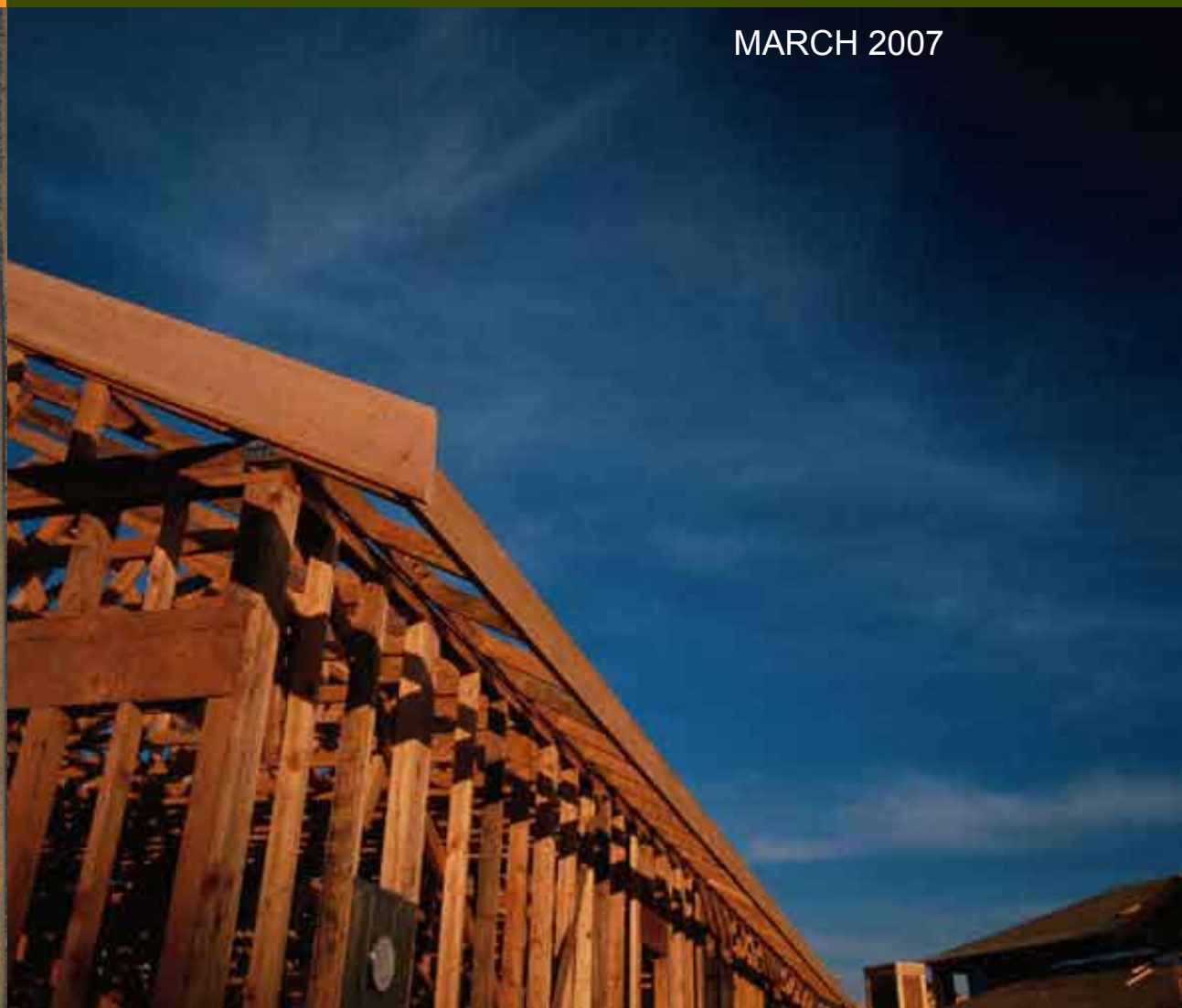
Australian Government
Forest and Wood Products Research and Development Corporation

MARKET KNOWLEDGE & DEVELOPMENT

PROJECT NUMBER: PN05.1022

Emerging technologies and timber products in construction - analysis and recommendations

MARCH 2007



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Emerging technologies and timber products in construction – analysis and recommendations

Prepared for the

Forest and Wood Products Research and Development Corporation

by

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The FWPRDC is jointly funded by the Australian forest and wood products industry and the Australian Government.

Australian Government

Forest and Wood Products Research and Development Corporation

Publication: Emerging technologies and timber products in construction – analysis and recommendations

Project no: PN05.1022

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Final report received by the FWPRDC in November 2006.

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1. Overview & Scope of Report

This document contains a summary of the analysis and assessments undertaken on the products, systems and technologies identified in the project PN05.1022 - 'Emerging Technologies and Timber Products in Construction', funded by the Forest & Wood Products Research & Development Corporation (FWPRDC) of Australia. In addition, the assessment methodology is outlined together with discussion on the results and recommendations for the consideration of industry and other interested parties.

Full details of all the products systems and technologies that have been included in this study are given in the 'Compendium of Products and Technologies' which should be read in conjunction with this report.

A number of emerging products, systems and technologies (ESTs) reported on in the compendium (as collected by a group of consultants that undertook an international survey) have not been included in this final assessment and report as they were deemed to be either already in existence in Australia or were already well known by Australian industry. Eighty eight (88) of the total one hundred and fourteen (114) ESTs given in the compendium are included in this report.

The final 88 products, systems and technologies identified and included in the assessments have been broadly grouped into 10 categories or combinations thereof, generally representative of their relevance to industry. These categories, and the abbreviations used herein are as follows:

CLI: Cladding, Lining, Insulation
EWC: Engineered Wood Component
FL: Flooring
IW: Improved Wood (coated, treated, modified etc)
MISC: Miscellaneous
PC: Panelised Construction
PFH: Prefabricated Factory Housing

RP: Research Project

SS: Structural System

WC: Wood Composite (including recycled wood)

A breakdown of the ESTs by category and country of origin, is given in Tables 1 and 2 below.

Table 1 – ESTs by Category

Category	Submitted	Included
Structural System	19	18
Panelised Construction	18	18
Improved Wood	15	14
Miscellaneous	17	11
Engineered Wood Product	11	3
Cladding, Lining, Insulation	10	3
Prefab Factory Housing	7	6
Flooring	6	4
Wood Composite	6	6
Research Project	5	5
TOTAL	114	88

Table 2 – ESTs by Country

Country	Submitted	Included
USA	32	27
Japan	13	13
NZ	20	9
Sweden	10	9
Netherlands	6	6
Finland	5	5
Germany	5	5
Canada	5	4
Norway	10	3
Switzerland	3	3
Austria	1	1
China	1	1
Denmark	1	0
France	1	1
UK	1	1
TOTAL	114	88

2. Analysis Methodology

In order to assess the potential impact and applicability in Australia of the products, systems and technologies identified in this project, a four step methodology was developed and applied to the 88 entries included in the study. The assessments are based on a semi-quantitative, criteria-based method and a more qualitative, intuition-based calibration and reality check of these by the authors together with an 'expert' third party. In addition, four additional external parties/groups performed informal intuition-based assessments to provide a check on the general validity of the results.

The following paragraphs provide a summary of the four step assessment process:

Step 1 – Determine scores for each of five criteria for every technology

The consultants that undertook the technology surveys were requested to comment on and rate the ESTs under a series of headings and sub-headings (representing the range of assessment criteria to be considered). Consultants assigned each of the ESTs a rating under the five criteria headings using a scale from +5 (best) to -5 (worst). This type of assessment was adopted to allow for trade-off between positive and negative aspects of the technologies. These comments and ratings were then reviewed and amended by the researchers and, where the consultants did not provide comments or ratings, the researchers included their own views and ratings. The criteria that were used, for the assessment are outlined in Table 3.

Table 3 – Criteria and Weightings Used For Criteria-Based Assessments

1 - Australian Context (Weighting = 1.5) • Specialist skills or equipment requirements • Regulatory Issues • Impact on structural robustness • Network change • Overall fit with Australian context
2 – Sustainability (Weighting = 1.0) • Lifecycle contribution to greenhouse gas emissions • Impact on residential energy consumption • Design life expectancy • Life cycle analysis • Renewability • Impact on pollution • Recycling implications • Waste implications • Overall Impact on sustainability
3 - Cost/Time/Quality (Weighting = 1.5) • Impact on costs - LABOUR • Impact on costs - OH&S • Impact on costs - MATERIALS • Impact on costs - LIFE CYCLE • Impact on costs - EQUIPMENT • Impact on costs - OVERALL • Impact on construction quality • Impact on construction time • Impact on % timber product volume • Impact on % timber product value
4 – Market (Weighting = 1.0) • Barriers to entry • Effort required to penetrate market and realize returns • Technical complexity • Product support requirements • Strengths • Weaknesses • Opportunities • Threats
5- Other (Weighting = 1.0) • Impact on style and attractiveness • Impact on durability • Impact on fire resistance • Impact on acoustic performance • Impact on structural performance / robustness • Impact on indoor air quality • Impact on OHS

Step 2 – Apply weightings to criteria scores

Based upon the authors expert knowledge, and supported by recent findings by Bull (2005), two of the criteria, '*Australian industry context*' and '*Cost/time/quality*', were assigned a weighting factor of 1.5. All five criteria were then summed, and normalised to a scale of 0 (least potential) to 10 (greatest potential). This resulted in individual criteria-based ratings for the ESTs ranging from a maximum '7.3' out of 10 to a minimum '2.7 ' out of 10.

Step 3 – Intuition-based ratings applied by different parties

Next, intuition-based rankings were assigned to each of the ESTs to provide a reality check for the criteria based assessment method described in Steps 1 and 2, and to highlight any inconsistencies in the criteria scores. The intuition-based ratings were performed independently by both researchers (trying to maintain isolation from the criteria-based assessments), and also formally by a third-party expert (external to the finer details of the project). The results of the three intuition-based assessments were then averaged. A rating system from 0 (worst) to 10 (best) was used to allow comparison and cross checking of the normalised criteria-based scores.

The intuition-based assessment from the two researchers resulted in individual overall ratings for the ESTs ranging from ('8') max to ('0') min. The third party review resulted in individual overall ratings for the products, systems and technologies from ('7') max to ('2') min.

The third party reviewer is currently a timber association Chief Executive with extensive marketing and market development experience in both the corporate and association sector in both the timber and competitive building materials sectors. It should be noted, that this person's intuition-based ratings were not influenced at all by knowledge of the detailed criteria-based ratings. (i.e., they should be purely expert intuitive knowledge).

Four additional external parties/groups (with trade-based backgrounds) also provided informal intuition-based assessments to provide an additional check on the overall soundness of the intuition-based assessments results. These informal comments are not reported herein, except to say that there was general agreement with the overall assessment described above, with a few exceptions which were considered to be influenced by the trade-based backgrounds of the parties.

Step 4 – Cross-check and calibrate criteria-based assessments

The final iteration in the review and assessment process involved revision of the criteria-based ratings (where appropriate) derived from Steps 1 and 2, by considering the averaged intuition-based opinions of both the researchers and external party (from Step 3). Overall, the criteria-based and intuition-based assessments matched reasonably well, however some minor adjustments to the criteria scores for a handful of ESTs were necessary to ensure consistency of ranking and trade-off between the technologies.

3. Analysis Results and Discussion

3.1 Overview

Table 4 gives a complete summary of both the criteria-based and the intuition-based ratings, and a comment on the overall potential of each of the ESTs. Full details and data for both the intuition-based and the criteria-based assessments are given in Appendix A, Tables A1 to A8. The ESTs in all tables are listed in order from highest to lowest ranked, according to the averaged intuition-based assessments. The intuition-based ratings once averaged, ranged from highest (best) 6.7 to lowest 1.7.

It should be noted that the results of the analysis presented in Table 4 must be considered in the context of the following practical considerations inherent in the assessment process used:

- No overall potential commercial value (i.e. quantification of, or potential for financial return) has been considered
- Each EST has been evaluated in it's own right within the broad categories allocated (for example, a product, system or technology may only have been considered as having potential in a niche market, but may be rated quite highly, whilst another, which may have a very wide market potential, may be given a lower rating)

3.2 Results

3.2.1 Terms

The terms used in Table 4 are defined as follows:

Name: Name allocated to the product, system or technology as provided by the consultants (may be generic, corporate, trade etc)

Country: Country of origin of product, system or technology, as provided by consultants

ID: I dentification number allocated to product, system or technology

Cat.: Broad category applied to product, system or technology. See Section 1.

Intuition Score: Average intuition-based score (0 to 10 scale) of three reviewers applied to indicate potential to have impact or be commercially successful.

Criteria Sore: Averaged weighted and normalised score on a scale of 0 to 10 based on the following five criteria: Australian Industry Context, Sustainability, Cost/Time/Quality, Market and Other;

Comments: Researchers' comments mainly related to their knowledge of product potential within the Australian context.

Table 4 - Summary of EST Assessments

Name	*Country*	*ID*	*Cat.*	*Intuition Score*	*Criteria Score*	*Comments*
MHM Solid Wood Wall	Germany	205	PC	6.7	7.0	The concept of a glue free, nailed only, fully automated manufactured panel is appealing. Material cost would be a possible issue, but it may suit use of low grade timber. Panel thickness would need to be scaled back to fit the Australian context.
Fort Housing System	Netherlands	214	PC PFH	6.3	6.6	Cost of this system may be an issue in single family dwellings, although design flexibility is impressive in fully CAD-automated factory. Seems like a natural extension of prefabricated wall frames as per Australian practice.
Leno®-Massiv Timber Systems	Germany / Italy	207	PC	6.0	6.2	This system uses very large volumes of timber which, if it was suitable for utilising low grade plantation softwood, could have potential for development in Australia providing cost issues were addressed. Use of glue may have some air quality implications compared to similar nailed products. Again, panel thickness would need to be scaled back to fit the Australian context.
SödraSmart	Sweden	910	MISC	6.0	6.2	This system fits with the current industry desire to try and develop non-load bearing systems for non-residential high rise buildings and would be worth further investigation in this light. Apparent ability to adjust for variations in floor/ceiling height seems a plus.
Carters Modular	NZ	101	PFH	5.7	6.9	This type of modular factory fabricated housing should have excellent potential where directed at repetitious developments such as townhouse/unit/motel construction.
Fibre Angle / Heartwood Content Measurement in Sawn Wood	Sweden	313	IW	5.7	6.9	Any processes that can be economically introduced at the green chain to better sort or characterise timber prior to downstream processing is very worthy of pursuit or further investigation, but no doubt this technology has already been identified by Australian producers.
TITAN Wood Chemical Wood Modification	UK / Netherlands	307	IW	5.7	7.1	Any product or system that can markedly improve the durability and stability of wood at an economical cost and without the need for 'preservative' chemicals, should have enormous potential.
Kebony Wood Treatment	Norway	310	IW	5.7	7.1	This improved wood/treatment process is a very encouraging and positive initiative as it has the potential to address many of the environmental shortcomings of conventional treatment if the economies and claimed properties are realised. Australia has the necessary biomass industry (sugar cane) to provide the furfuryl alcohol. The costs of the process are reported to be a significant issue as well as the industrial considerations associated with the use of furfuryl alcohol and high temperatures.
Tumiki House - Timber Block House	Japan	610	SS	5.7	6.6	A very simple system that utilises 'low' grade softwood. Potential for this system in niche markets such as holiday cabins, kit cubby houses, etc. System may suit 'business profile' of some existing Australian timber furniture component manufacturers.
Unilogs	NZ	601	SS	5.7	5.6	A simple concept which could make the use of small diameter round logs (plantation hardwoods and softwoods) feasible in a range of applications, including industrial, niche commercial and multi-storey multi-residential construction.
TEHA Modular Building System	Netherlands	102	PFH	5.7	5.3	System may suite repetitious type designs such as townhouses, flats, etc where economies of scale and fixed designs prevail. Like all factory fabricated systems, requires a large capital investment before returns are potentially realised. Potential of these should be considered with external 'add-ons'/finishes such as decks/verandahs,

Name	Country	ID	Cat.	Intuition Score	Criteria Score	Comments
						etc.
Steko-Blocks	Switzerland	614	SS	5.3	6.6	Similar to Tumiki, except that Steko blocks have the added advantage of cavity for services etc. The cost will be an issue and also wall thickness would need to be reduced to fit Australian housing context. Need to address tie-down and also racking issues but these should be easily accommodated. See Tumiki comments ID 610.
Natwood Oil Modification	Austria	306	IW	5.3	6.8	If it is inexpensive as claimed, then it would have potential application in Australia to improve timber's durability performance.
ThermoWood	Finland	308	IW	5.3	6.4	This product is another example of the growing 'non-chemical' developments to improve timber's durability performance. As such, it is worth serious consideration for it's potential to provide an alternative to chemical treatment.
SubstiWood	USA	406	WC	5.3	6.3	Potentially, a good development for utilising wood waste. Advances in recycling technology may be applicable.
MIFS Window Socket Flashing System	USA	906	MISC	5.3	6.5	An innovative idea/product. It addresses a number of issues associated with openings. Cost may be a consideration and, in bushfire prone areas, fire may be an issue if components are plastic. May have advantages for single skin masonry walls.
Open Prototype Initiative	USA	1001	RP	5.3	6.6	A very promising and ambitious initiative with the potential to drive uptake of new technologies, especially in the US. This project is aiming to explore prototype solutions to the long-term and 'big-picture' issues in construction. It addresses many of the issues raised in the literature review. Has a worthwhile website.
Solid Wood Elements	Norway	206	PC	5.3	6.2	Cost of the massive panels may be an issue and also, as they are solid, the need to cater for running services becomes a consideration. Gluing may have an impact on indoor air quality. Where technically applicable, panel thickness would need to be scaled back to fit the Australian context.
Durisol Building Systems	Canada	401	WC	5.3	6.1	Reconstituted cement based wood panels or products offer a multitude of potential opportunities to the timber industry for both recycling low grade / contaminated / treated timber and new/substitution market development.
Integrated Interior Infill Modules	USA	1004	RP	5.3	5.8	A very futuristic concept with some merit if it can be realised in a viable way in the construction industry of the future.
Flexible Framing Track	USA	909	MISC	5.0	7.1	Great idea that addresses a specific design issue. Similar (same) system reported to be already available in Australia.
WoodHeart	Finland	309	IW	5.0	6.7	Limited application in Australia for easily treated plantation softwoods, but may increase as we try and utilise small diameter plantation hardwoods. Definite opportunity for cypress which has refractory (can't treat) sapwood, but durable heartwood. In this regard, opportunities would be verandah posts and similar exposed to the weather.
Greenweld	NZ	903	MISC	5.0	6.7	Potential is obvious, although not completely relevant to the goals of this project. Should be included in study however to flag interest. Some Australian companies have already looked at it.
Wood Welding	France	1005	RP	5.0	6.6	May have some application in manufactured housing applications, but perhaps is not economically viable except for specialised applications.
M-Wood 2	Japan	405	WC	5.0	6.3	Similar products (Modwood) are already available in Australia and are gaining market share as replacements for solid timber. Advances in recycling technology may be applicable.
OSBA House Chassis	USA	1003	RP	5.0	5.9	A very futuristic concept with some merit if it can be realised in a viable way into the construction industry of the future. Typically for MIT, this project is hugely ambitious, and way ahead of it's time. Houses and structures in general are becoming more and more about the embedded services that make a space functional, and are demanded by occupants. This concept could well be the most efficient way to meet this requirement in the future.
Bamboo-Based Construction Products	China	908	MISC	5.0	5.9	Possible replacement for some wood-based construction products such as panels, beams, mouldings and flooring. This could become a threat to wood if Chinese bamboo industry continues to expand and price drops significantly. May also be niche markets for use of the raw culms in eco-friendly developments, tourism, etc. May need treatment as lyctine susceptible.
Recycled Wood Chip Spraying - Civil Engineering Technology	Japan	914	MISC	5.0	6.0	No information is available on what the binder, if any, is. May also be susceptible to termite damage, but this may not necessarily be a negative thing. May also be susceptible to fire damage. Any uses that provide a means to profit add to utilise waste timber products is worth pursuing.
Lignotrend Timber Systems	Germany	204	PC	5.0	5.9	Cost of this system may be an issue in single family dwellings where acoustic etc performance is less of a criterion. Also, ability to locate air-conditioning and heating ducts would need to be addressed.

Name	*Country*	*ID*	*Cat.*	*Intuition Score*	*Criteria Score*	*Comments*
Internal Facades System	Netherlands	201	PC	5.0	5.5	An interesting concept which could potentially be a niche market for prefabricated factory-built timber framed panels in concrete tilt-up construction
j.Pod - Recurrent Light-Frame Building System	Japan	613	SS	5.0	5.3	This construction method may be suited to repetitious multi residential construction in it's current form, but design flexibility may limit applications elsewhere. If this issue can be overcome with clever design software such as used by the nailplate industry, then this could have much greater application, as it would allow for the current wall, roof and floor truss fabrication industries to expand applications, and possibly integrate for whole house framing.
DuroWell	Switzerland	904	MISC	4.7	5.8	Commercial application of the developing generic 'wood welding technology' may be limited to specialised applications such as manufactured housing.
Ein Super Wood	Japan	404	WC	4.7	5.9	Similar products (Modwood) are already available in Australia and are gaining market share as replacements for solid timber. Advances in recycling technology may be applicable.
Massive Timber Systems Die Brettstapelbauweise	Germany	202	PC	4.7	5.9	Cost of this system may be an issue in single family dwellings where acoustic etc performance is less of a criterion. Also, ability to locate air-conditioning and heating ducts would need to be addressed. The simple use of nails to laminate appeals. Would be advantageous if panels can be potentially made from low-grade material.
Genetically Altered Wood	USA	303	IW	4.7	4.8	Very long term possibilities.
RBS Encapsulated Building System	Canada	604	SS	4.7	4.3	Similar to polystyrene/block concrete core filled construction, except formwork has advantage of external and internal final finish.
Quattrolit	Sweden	314	IW	4.3	5.8	Limited application in Australia for easily treated plantation softwoods, but may increase as we try and utilise small diameter plantation hardwoods. Definite opportunity for cypress which has refractory (can't treat) sapwood, but highly durable heartwood. In this regard, opportunities would be verandah posts and similar exposed to the weather.
GIB Braceline	NZ	606	SS	4.3	5.8	Local plasterboard manufacturers have withdrawn their bracing products and this would be a suitable alternative. It would however be a competitor to some wood based bracing systems as well as fibre cement.
Comwood	Sweden	504	EWC	4.3	5.9	These products would have potential limited/niche markets in Australia, and durability would need to be considered.
Wintec Modern Window Technology	NZ	901	MISC	4.3	6.1	May already be available in Australia, but full potential may not have been realised. Consider this type of window joinery would have good potential if the advantages of the 'turn/tilt' to capture breezes were recognised as potential energy savings under our building regulations, particularly for warm/hot climate zones.
Mortarless Brick Veneer	USA	801	CLI	4.3	6.0	There would be an issue with the weight of this as it exceeds the assumed wall masses used for the timber framing code span tables wall frame tables. New tables that took account of the extra mass would need to be developed. Also cost may be an issue. Quote . from an industry competitor with a similar system was about $150/m sq.
HAL Industries INC.	Canada	803	CLI	4.3	5.3	This cladding system is designed as a base for stucco type finishes which are gaining market share in Australia. If using a wood based panel as the base, it has the potential to increase timber use in competition with fibre cement/masonry rendered/stucco wall claddings.
Wood-Polymer Lumber	USA	402	WC	4.0	5.7	These products are available and in use in Australia now.
The SoundBar System	Finland	701	FL SS	4.0	5.9	There are some similar systems available in Australia, but not offered as a total package. This type of system would help address the impact and structure-borne noise issues timber has in multi-residential construction. Introduction of a wet trade (self levelling compound) is a bit of a drawback.
Lignatur Floor Systems	Switzerland Germany	703	FL PC	4.0	5.9	Cost of this system may be an issue in single family dwellings where acoustic, etc performance is less of a criterion. Also, ability to locate air-conditioning and heating ducts would need to be addressed.
Plastic Composite Nails	USA	907	MISC	4.0	5.9	A specialist product for very specific applications that are not structurally demanding.
KAUNA PANEL	Sweden	312	IW	4.0	5.8	This process may be worth further investigation to determine its value and economics in respect of high value external timber applications that are now quite 'trendy' in Australia i.e. screens, solid timber cladding, etc. It may not work on higher density hardwoods.
CELL+FUNEN	Japan	305	IW	4.0	5.4	Although Boron/borate treated fire retardant timber is currently available in Australia This technology may be worth further investigation with respect to what is different about it, and how it may affect bushfire resistance and interior products requiring fire ratings under the BCA.

Name	Country	ID	Cat.	Intuition Score	Criteria Score	Comments
Super Wall Construction Method	Japan	617	SS PC	4.0	5.4	Post and beam and insulated panel system seems to be quite an expensive system in the Australian context. Possible applications in multi-storey multi-family units.
ABUILD Flitches	NZ	502	EWC	4.0	5.3	Some potential for their uptake in Australia for specific applications such as in high wind areas.
Structural Building Systems, Inc.	USA	210	PC	4.0	5.2	Structural insulated panels are considered to have some potential in Australia as our energy ratings are escalating, but would displace solid timber.
THERMAPAN	Canada	211	PC	4.0	5.2	Structural insulated panels are considered to have some potential in Australia as our energy ratings are escalating, but would displace solid timber.
Pacemaker Building Systems, Inc.	USA	209	PC	4.0	4.8	Structural insulated panels are considered to have some potential in Australia as our energy ratings are escalating, but would displace solid timber.
UN Building System	Netherlands	203	PC	4.0	4.7	The thickness of wall panels may be an issue in the Australian context and also costs would need to be considered where such high levels of insulation are not required here.
SIMPSON Strong Tie Walls	USA	602	SS	4.0	4.4	May have limited application in Australia in high wind areas or where housing designs have limited external wall space for bracing.
Radiant Barrier Sheathing - Plywood or OSB	USA	802	CLI	4.0	4.0	This type of technology has already been tried and may still be available in Australia on plasterboard. May have some application now as reflective wall bracing, now that the plasterboard suppliers have pulled out of the bracing market.
SemiBjälklaget	Sweden	702	FL PC	3.7	5.5	This panelised floor system would have potential application in multi-residential/commercial construction, but the maximum spans given would be a limiting factor in Australian markets where 6.0m seems to be a typical minimum sought. Cost of this system would also be a consideration.
R-Control	USA	208	PC	3.7	4.8	Structural insulated panels are considered to have some potential in Australia as our energy ratings are escalating, but would displace solid timber.
LP Smart Side	USA	301	IW CLI	3.7	4.3	If there was an Australian OSB manufacturer, greater potential for this type of product in Australia could be anticipated.
ND NanoCides	USA	315	IW	3.3	5.2	Main potential in Australian context would be improved durability properties as mould and health issues are not at the forefront here just yet.
Panelized Housing	USA	217	PC PFH	3.3	5.7	This type of housing would require a philosophical change in delivery of housing in Australia.
PULTE HOMES, INC.	USA	103	PFH	3.3	5.0	Not sure if this is factory fabricated, but if so, seems to be a home builder that delivers the total package like Australian builders but from a factory base.
Hybrid Modular/Panelized Systems	USA	218	PC PFH	3.3	5.0	This type of housing would require a philosophical change in delivery of housing in Australia.
TECHNOSTRUCTURE	Japan	607	SS	3.3	5.0	This seems to be quite an expensive system in the Australian context. However, the system may have some attributes that would be worth exploring such as the plenum floor system.
GRB Jamb Tie	NZ	902	MISC	3.3	5.0	May have some relevance for DIY application. Impact will be relatively small.
Modular Systems With SIP Panels	USA	213	PC PFH	3.3	4.3	This type of housing would require a philosophical change in delivery of housing in Australia.
Hinged Roofs	Netherlands	215	PC PFH	3.3	4.3	Novel, but limited potential in Australia, unless coupled with other prefabrication. Roof design flexibility would be constrained eg hips, Dutch gables, etc.
Timberbond Flooring	NZ	704	FL EWP	3.0	5.0	Laminated timber flooring slabs are not new and would appear to have limited market uptake in Australia.
IK METHOD - New Structure System	Japan	609	SS	3.0	4.6	This construction method using rigid moment resisting frames would probably add significant costs to housing and may only have potential application in commercial style construction. Skills required to install would be similar to a 'heavy' steel framed building.
Big Frame & ProudioBF	Japan	611	SS	3.0	4.6	This construction method using rigid moment resisting frames would probably add significant costs to housing and may only have potential application in commercial style construction. Skills required to install would be similar to a 'heavy' steel framed building.
SE Structure Method	Japan	612	SS	3.0	4.6	This construction method using rigid moment resisting frames would probably add significant costs to housing and may only have potential application in commercial style construction. Skills required to install would be similar to a 'heavy' steel framed building.
HSTPU - High Strength Timber Panel Unit	Japan	618	SS PFH	3.0	4.8	This panelised/post and beam system appears similar to the Super Wall system. It also includes a plenum floor space which may have advantages in Australia to address 5 star energy issues in cold climates. Again, this seems that it would be quite an expensive system in the Australian context. Need more information on what the

Name	Country	ID	Cat.	Intuition Score	Criteria Score	Comments
						actual panels are.
G-Frame Construction	Japan	608	SS	3.0	4.6	This construction method using rigid, moment resisting frames would probably add significant costs to housing and may only have potential application in commercial style construction.
Ridgified Inflatable Structures	USA	1002	RP	3.0	4.7	Too early and insufficient information available yet to make any valued assessment, however if the claims regarding cost are correct and the technology to commercialise into producing housing is achieved, then could be a real threat to all existing conventional housing.
Building Innovation Industries, LLC.	USA	212	PC	3.0	2.8	Potential threat to timber framed construction. Environmental and fire issues.
Alvsbyhus	Sweden	104	PFH	2.7	5.0	Appears to concentrate on a limited number of fixed house designs, so it is likely to have limited acceptance in Australian market for mainstream housing.
Kontio Loghouses	Finland	615	SS	2.7	4.3	There are a number of existing log structures/systems already in Australia that have established small niche markets for holiday cabins, etc. This system seems quite sophisticated compared to Australian methods and could probably only be justified here if much greater numbers were built.
Rantasalmi Oy	Finland	616	SS	2.7	4.3	There are a number of existing log structures/systems already in Australia that have established small niche markets for holiday cabins, etc. This system seems very sophisticated compared to Australian methods and could probably only be justified here if much greater numbers were built.
Steel-Expanded Polystyrene System	USA	605	SS	2.7	4.3	This structural steel/polystyrene system would be a competitive replacement for timber framed construction.
KARTRO LÄTTREGEL	Sweden	501	EWC	2.3	3.9	Applications for this system within the Australian market would be very limited, as wall thickness is an issue.
Steel Stud System - TSN	USA	603	SS	2.3	3.1	Potential composite timber steel, may have some limited application in high wind areas for bracing/tie-down.
Koljern	Sweden	905	MISC	2.3	3.0	A novel idea in the sense that it is a 'pre-manufactured' foundation system with high insulation properties, although would appear to be expensive compared to existing systems.
Loft Cube	Germany	105	PFH	2.0	4.2	A novel concept that may have limited or niche market appeal.
Hedalm Laft AS	Norway	106	PFH	2.0	4.3	There are a number of existing log structures/systems already in Australia that have established small niche markets for holiday cabins, etc. This system seems quite sophisticated compared to Australian methods and could probably only be justified here if much greater numbers were built.
Composite Fabric Reinforced Plywood	USA	403	WC	2.0	3.9	Specialist applications only.
ZIP System Roofing	USA	302	IW	2.0	2.7	Similar to LP Smart Side, would significantly increase construction costs in Australia as we do not use shingle/asphalt based roofing.
Lignia Hardened Pine	NZ	304	IW	1.7	3.9	Very limited application or potential in context of this project. Similar products being pursued in Australia ('Vintorg').
ACES	Netherlands	216	PC PFH	1.3	4.4	Perhaps applicable but there is insufficient information on this technology to assess due to difficulty accessing COST E29 Symposium proceedings.

3.3 Discussion of Results

3.3.1 General

Table 4 demonstrates the similarity and close parity between the intuition-based ratings and the criteria-based ratings derived using the five-criteria method. There are some disparities for some individual ESTs between these rating systems and the key ESTs will be discussed later.

The top 10 rated systems and technologies comprise an array of categories including Panel Construction, Prefabricated Factory Housing, Structural Systems and Improved Wood. At the other end, the lowest 10 rated systems also comprise an array of similar categories, which probably reflects their general inapplicability to the Australian context or possible very high costs.

The following provides discussion with respect to each category of ESTs. Where possible (based upon the rankings of the technologies, as outlined in Table 4), the comments are focussed on those ESTs that are considered to have the greatest potential for impact or commercial uptake.

3.3.2 Highest Impact ESTs

CLI – Cladding/Lining/Insulation

None of the three identified CLI products rated all that well (4.0 to 4.3) being around the middle of the full list of products. No further discussion is provided on these products/systems.

HAL Industries (803)

EWC – Engineered Wood Component

Again, none of the three EWCs rated highly. There may be some potential for **ABUILD Flitches**, or a similar style steel/timber composite beam, to have niche applications where a high strength (minimum depth beam) is required such as in lintel/garage or ring beams in high wind areas.

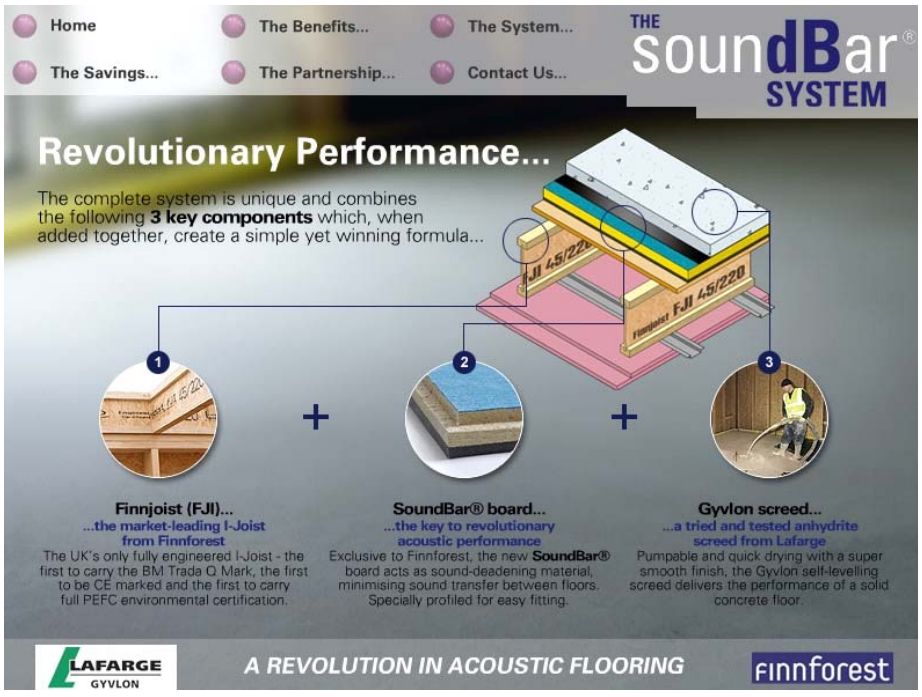
The **Comwood** laminated pole would also only have very specialised niche market appeal where cost was not really an issue. Similar machined and profiled solid poles have been produced in Australia for specific applications, but only on a 'one–off' basis to the best of knowledge.

Comwood (504)

Abuild Flitches (502)

FL/PC – Floors/Panelised Construction

Again, no real 'stand-outs', with ratings around the 3 to 4. The Finnish **Soundbar** System addresses one of the key issues we are facing in Australia in the uptake and acceptance of fire and sound rated timber framing in multi storey residential and commercial buildings. This type of system would help address the impact and structure-borne noise issues in this type of construction, however introduction of a wet trade (self levelling compound) is seen as a drawback.



SoundBar System (701)

IW – Improved Wood (coated, treated, modified etc)

Fourteen technologies/products were identified in this broad category with rankings from high (5.7) to very low (1.7). In the timber processing area, the Swedish research using laser and image technology on identifying **Fibre Angle** in heartwood at the transverse green chain point of processing has potential to better sort or characterise timber prior to downstream processing. It is anticipated that this technology has already been identified by some Australian softwood producers, however any technology that has potential to introduce early segregation of distortion prone timber should lead to improved timber quality and should not be discounted.

TITAN Wood Modification (acetylation) and **Kebony Wood Treatment** (furfuryl alcohol), whilst both chemical modifications, rank highly (5.7) in part, as they have the potential to address the current environmental issues and constraints being increasingly imposed on traditional preservative chemicals. Cost and WH&S manufacturing issues of both of these processes need to be considered in terms of commercial uptake as well as long term efficacy of the modifications in respect of claimed durability enhancement.

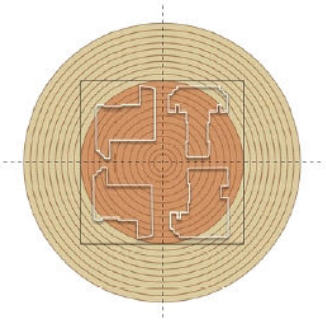
Ranked slightly lower (5.3), the **Natwood Oil** resin/temperature modification and **ThermoWood,** thermal modification also have potential to provide timber with improved durability and stability without significant environmental issues. Economical processes that address both durability improvement and stability have excellent long term potential in the Australian context as mechanical degradation (due to moisture uptake/loss) often dominates timber's service life eg CCA treated decking and cladding.

Woodheart and **Quattrolit** (5.0 and 4.3) may have some potential as systems to re-manufacture refractory species (small diameter eucalypts and cypress etc) with durable heartwoods into external quality products, but again stability to moisture for glued laminated products needs serious consideration.

Genetically Altered Wood presents very long term possibilities, and a watching brief is suggested for further developments with this emerging science.

Titan (307)

Kebony (310)



WoodHeart (309)

MISC – Miscellaneous

The miscellaneous category includes 10 products or systems, wood based and non-wood based, that generally do not fit within the broad categories assigned to the others. Again rankings extend from relatively high (5.3) to low (2.3) and only the higher ranked are discussed further below.

Although not a timber product, the **MIFS** window socket system (5.3) is an innovative idea that takes the guess work and on-site trade skills out of the successful installation of weatherproof windows by removing the on-site flashing requirements. It also has the ability to provide tolerances to those normally required in window framework layout. This product had high appeal to the trade experts that reviewed it, presumably because of it's practicality, but may offer more advantage to single skin masonry walls than to timber framed walls. Definitely a 'big box' contender.

The **Flexible Framing Track** also ranked fairly highly (5.0) and is suitable for both timber/metal and metal/metal wall frames. This product or variant thereof is already well established, promoted and readily available in the Australian market so is not discussed further.

The NZ **Greenweld** system for gluing timber at high moisture content also ranked fairly highly (5.0), but is already in commercial use internationally and well known to much of Australia's timber industry.

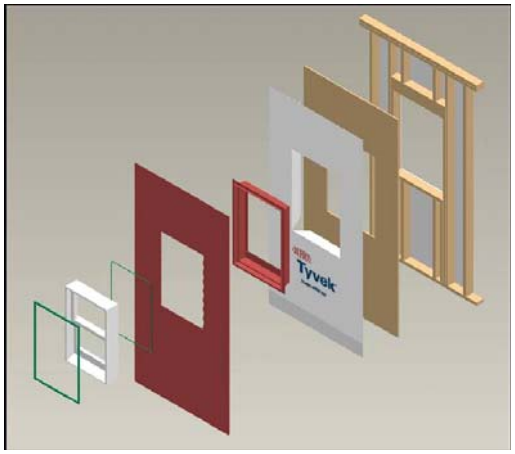
Bamboo-Based Construction Products (5.0) will continue to develop and evolve as replacements and substitutes for conventional timber and as they are seen to have 'eviro-cred', they will have strong appeal to the sustainability minded. This is already evidenced in Australia with the 'engineered' bamboo flooring products available and in use that have now established significant market share. Technically there is nothing to suggest that engineered structural bamboo products and composites cannot also challenge conventional timber products and composites.

Recycled Wood Chip Spraying (5.0) may be a product system that appeals to timber recycling interest and may also provide an option for the utilisation of treated timber waste, depending upon the civil infrastructure owners' requirements. Further information is needed to properly assess the potential for this product.

The Swiss **DuroWell** wood welding (4.7) is emerging technology that may have medium to long term application for specialised product manufacture such as where already being used in Europe for linear applications such as laminating blanks for snow boards.

Wintec windows whilst only medium rated (4.3) have significant potential to capitalise on Australia's increasing regulatory energy efficiency requirements as they are totally adjustable to catch prevailing breezes and this type of window would be well positioned by current and future regulations.

Plastic Composite Nails are a specialist product that will have obvious niche markets where low structural, but high corrosive resistance is required.



Mifs (906)

Flexible Framing Track (909)

PC – Panel Construction

Twelve products and systems were identified under this category ranging from a very high 6.7 to a low 3.0. Many of these fall into a 'massive' or solid wood wall/floor/roof system but with quite varying degrees of rank.

The German **MHM Solid Wood Wall** was the most highly overall ranked system (6.7) or product identified in the survey and this is probably refected in the fact that the system is based upon the concept of a glue free, nailed only (aluminium), fully automated manufactured panel. Material cost would be a possible issue, but it may suit use of low grade timber and panel thickness would need to be scaled back to fit the Australian context and the 'engineering' attributes of this would need to be addressed.

Leno-Massiv Timber Systems, Solid Wood Elements, Lignotrend and Massive Timber Systems Die Brettstapelbauweise (6.0 to 4.7) are also similar solid wood systems, but being glued systems may have less appeal and also all have other drawbacks that may need to be considered in the Australian context such as panel thickness, ability to accommodate services etc.

The Netherlands **Internal Facades** system (5.0) may have appeal to Australian wall/truss factory fabricators who may wish to take their businesses to the next level with potential to grow their business in multi-residential and non-residential sector, by offering a more complete wall system.

MHM Solid Wood Wall (205)

Internal Facades System (201)

PC/PFH – Panel Construction/Prefabricated Housing

Of the six systems identified under this category, only the **Fort Housing System** rated significantly (6.3) and its appeal, putting cost aside for single family dwellings, is apparent impressive design flexibility and the fact that it is a fully CAD-automated factory fabrication. The system seems like a natural extension of prefabricated wall frames as per Australian practice. Other systems under this category did not rate well enough to be considered potentially of 'high impact'.

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Fort Housing System (214)

Thermapan SIPS (211)

PFH - Prefabricated Housing

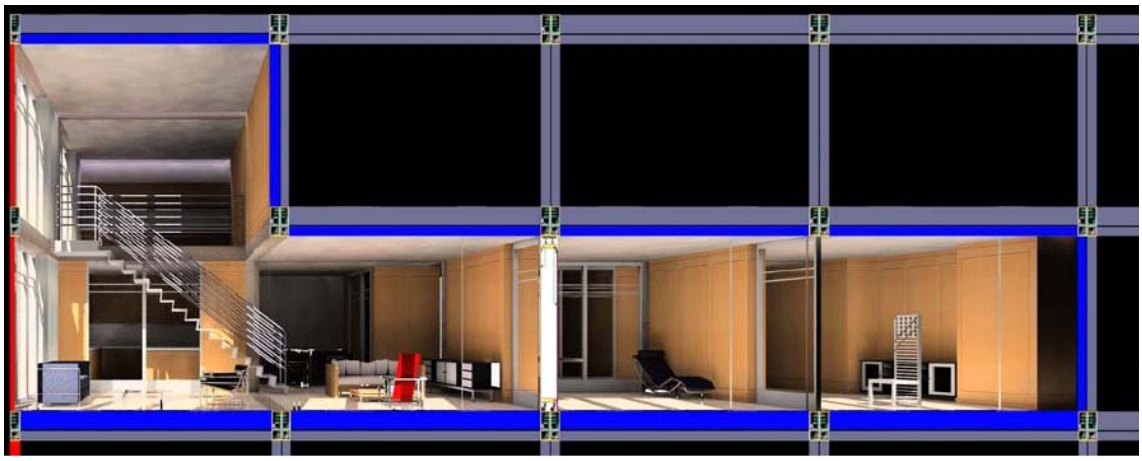
Again, under this category only the **Carters Modular** (NZ) and **TEHA Modular** (Netherlands) (both rated 5.7) are considered worth further discussion. Both systems are similar in concept and suit repetitious modular factory fabrication that may have appeal to existing prefabrication businesses that may be considering the 'next level' for business expansion. With Australia's growing trend to address housing affordability issues and reducing suitable single dwelling land availability, growth in the multi-residential construction sector is anticipated to continue which lends well to these systems.

Carters Modular (101)

TEHA Modular (102)

RP – Research Projects

None of the research products / technologies examined as part of the study is considered to be near to commercialisation. Regardless of this, projects which have MIT involvement will be worth watching as they are always at the forefront of futuristic thinking. MIT projects with potentially far-reaching implications include these include **OSBA House Chassis** and **Integrated Interior Infill Modules** and to a lesser extent, the **Open Prototype Initiative.** Other research technologies such as **Wood Welding** may have some application in manufactured housing applications, but is perhaps economically not viable at present except for specialised applications.



OSBA House Chassis (1003)

SS – Structural Systems

This category identified the largest number (19) of ESTs and these ranged from a high ranking (6.0) for **SödraSmart** to a low (2.3) for **Steel Stud System** which may be understandable. Within this category there were a number of 'log' and 'heavy' laminated framed structural systems identified which generally did not rank that highly and are not discussed further.

The five highest ranked of systems in this category are discussed below:
SödraSmart, technically this Swedish development is a non-loadbearing partition system but has been included in the SS category because of its general fit. It achieves the highest ranking (6.0) in this category and this probably reflects its compatibility with Australian framing systems and materials together with the fact that it aligns with the current industry desire to try and develop non-loadbearing systems for non-residential high rise buildings. In this regard, it would be worth further investigation. The system's apparent ability to adjust for variations in floor/ceiling height would also be a plus in addressing this market.

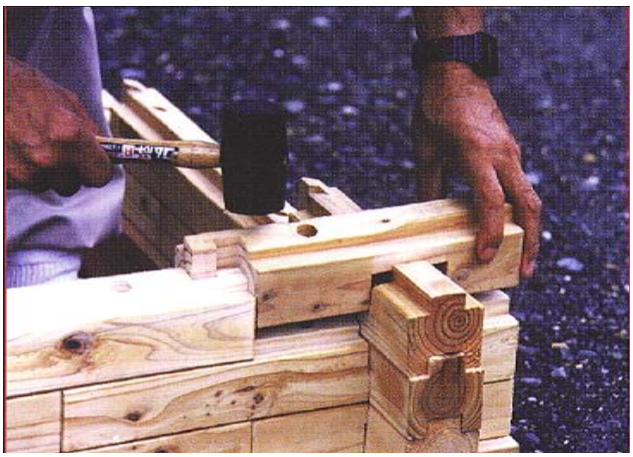
Tumiki Timber Block House (Japan) **and Steko-Blocks** (Switzerland) are similar in concept with relatively high rankings of 5.7 and 5.3 respectively. These unique and novel interlocking timber block systems are highly manufactured or machined and are constructed into structural wall systems, on site, similar to 'brick' laying. In their

'raw' form the external surface is timber, however other conventional lining/cladding materials could be applied over them. Both systems have the potential to utilises 'low' grade softwood. Potential is seen for the Tumiki system in niche markets such as holiday cabins, kit cubby houses etc. Steko blocks have the added advantage of a cavity for services etc. The cost of the systems may be an issue and also wall thickness for the Steko-blocks would need to be reduced to fit Australian housing context. These system may suit the 'business profile' of some existing Australian timber furniture or similar component manufacturers.

Unilogs (New Zealand) is ranked quite highly (5.7) and certainly provides a structural solution using a simple concept which could make the use of small diameter round logs (plantation hardwoods and softwoods) feasible in a range of applications, including industrial, niche commercial and multi-storey multi-residential construction. The key to the system is the uniform diameter rounds and matching 'off the shelf' metal connectors.

The j.Pod Recurrent Light-Frame Building System (Japan) ranked reasonably well (5.0) and may be suited to repetitious multi residential construction in it's current form, but design flexibility may limit applications elsewhere. If this issue can be overcome with clever design software such as used by the nail plate industry, then this could have much greater application, as it would allow for the current wall, roof and floor truss fabrication industries to expand applications, and possibly integrate for whole house framing.

Sodrasmart (910)

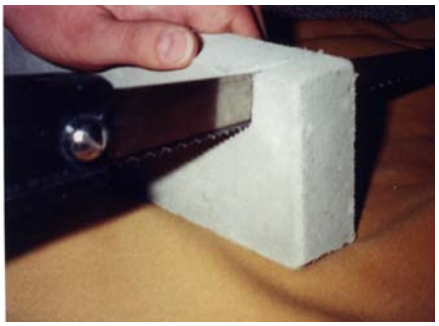


Tumiki House (610)

WC – Wood Composite (including recycled wood)

Six wood composite products were identified and the two highest ranked (5.3) were **Substiwood** (USA) and **Durisol Building Systems** (Canada). Both of these systems are cement bonded wood fibre products that are potentially good developments for utilising wood waste which, with advances in recycling technology may offer a multitude of opportunities to the timber industry for both recycling low grade/contaminated/treated timber and new/substitution market development opportunities.

The other WCs are not discussed further as markets and products are well established although the **Composite Fabric Reinforced Plywood** may present specialist opportunities for Australia's plywood manufacturers.



Substiwood (406)

Durisol Wood-Composite Masonry System (401)

3.3.3 Other ESTs ranked highly on criteria-based assessment

There were four ESTs that ranked highly on the criteria-based assessment (6.0 or higher), but were not considered to be 'high impact' for various reasons outlined below.

CLI – Cladding/Lining/Insulation

Mortarless Brick Veneer (USA) - There would be an issue with the weight of this as it exceeds the assumed wall masses used for the timber framing code span tables. New tables that took account of the extra mass would need to be developed. Also cost may also be an issue. An industry

competitor with a similar system quoted around $150/m^2$ for this type of cladding.

Mortarless Brick Veneer (801)

PC – Panel Construction

Leno-Massiv Timber Systems (Germany/Italy) - This system uses very large volumes of timber which, if it was suitable for utilising low grade plantation softwood, could have potential for development in Australia providing cost issues were addressed. Use of glue may have some air quality implications compared to similar nailed products. Again, panel thickness would need to be scaled back to fit the Australian context

Leno Massiv Timber System (207)

WC – Wood Composite (including recycled wood)

M-Wood 2 (Japan) - Similar products (Modwood) are already available in Australia and are gaining market share as replacements for solid timber. Advances in recycling technology may be applicable

M-Wood 2 (405)

4. Recommendations

Whilst this international survey and review of emerging systems and technologies has not revealed any obviously 'earth shattering' or 'industry-killing' technologies or products, it has identified a number of possibilities that, if modified, or intelligently considered in the Australian context, could provide the timber or building industries with some ideas for further development, that may lead to commercial uptake and potential benefit to industry.

In respect of this, it is known that the following issues are high priorities for Australia's timber industry, the plantation sector in particular:-

- improved and more consistent log resource
- more efficient production techniques
- improved profitability from low grade material
- profit adding and utilisation of by-products/residues/recycled timber
- less reliance on/diversification away from the domestic housing sector
- greater market share in commercial and industrial construction.
- new market development opportunities
- potential to develop export opportunities

Whilst this report provides a review, comment and a summary of the recommendations of the researchers, it is **recommended** that industry and other interested parties, access and review the full 'Compendium of Products and Technologies' which will be available from www.fwprdc.org.au (subject to confidentiality considerations) as, undoubtedly there will be other ESTs that have not being considered highly in this review that may suit the business profile and directions of specific companies.

The ESTs given in Table 5 are considered worthy of further consideration and investigation by industry or relevant interest category in respect of the above priorities.

TABLE 5 - Selected ESTs Relevance to Australian Timber Industry Priorities

Relevant category	*Product, System or Technology*	*ID*	*Improved resource*	*Production efficiency*	*Low grade use*	*Utilisation residues*	*Diversification*	*Market share*	*New Markets*	*Export potential*
Grower or purchaser	Genetic Altered Wood	303	✓	✓	✓					
Timber conversion/ Production	ThermoWood	308			✓		✓		✓	
	MHM Solid Wood Wall	205			✓	✓	✓	✓	✓	
	Leno-Massiv Timber Systems	207			✓	✓	✓	✓	✓	
	Unilogs	601			✓		✓	✓	✓	
	Greenweld	903		✓	✓					
Recyclers	Recycled Wood Chip Spraying	914				✓	✓		✓	
	Substiwood	406				✓	✓	✓	✓	✓
	Durisol Building Systems	401				✓	✓	✓	✓	✓
Timber/ factory fabricators	MHM Solid Wood Wall	205			✓		✓	✓	✓	
	SödraSmart	910			✓		✓	✓	✓	
	j.Pod Recurrent Elements	613					✓	✓	✓	
	Internal Facades system	201					✓	✓	✓	
	Carters Modular	101					✓	✓	✓	
	TEHA Modular Building Systems	102					✓	✓	✓	
	Unilogs	601			✓		✓	✓	✓	
	ABUILD Flitches	502						✓	✓	
Furniture/ Component manufacturers	Tumiki House	610		✓	✓		✓	✓	✓	
	Steko-Blocks	614		✓	✓		✓	✓	✓	
Laminators	Comwood	504					✓	✓	✓	✓
	Quattrolit	314					✓	✓	✓	✓
	Woodheart	309					✓	✓	✓	✓
	DuroWell	904					✓	✓	✓	✓
	Greenweld	903					✓	✓	✓	
Treaters	Kebony Wood Treatment	310			✓		✓	✓	✓	✓
	TITAN Wood Modification	307			✓		✓	✓	✓	✓
	Natwood Oil Modification	306			✓		✓	✓	✓	✓
Product suppliers	MIFS Window Socket Flashing System	906					✓	✓	✓	
	WINTEC	901					✓	✓	✓	
	Plastic Composite Nails	907					✓	✓	✓	
	Unilogs	601					✓	✓	✓	
	Bamboo-Based Construction Products	908					✓	✓	✓	
Research Projects	Wood Welding	1005		✓	✓		✓	✓	✓	
	Integrated Interior Infill Modules	1004		✓	✓	✓	✓	✓	✓	

5. References

Bull, L. (2005) Commercialisation of Wood Product Innovations. University of Melbourne.

Appendix A – Data for Intuition-Based and Criteria-Based Assessments

Appendix A contains a summary of all of the data used for both the intuition-based and the criteria-based assessments described in Section 2. A list of the tables is given below. For the purpose of readability, two of the criteria categories are split into two separate tables with matching criteria scores. The two sets of 'split' tables with matching criteria scores are indicated below with '*' and '**'.

Table A1 - Summary of Intuition-Based and Criteria-Based Scores
Table A2 – Criteria Assessments: Australian Context
Table A3 – Criteria Assessments: Sustainability
Table A4 – Criteria Assessments: Costs *
Table A5 – Criteria Assessments: Quality / Time / Value *
Table A6 – Criteria Assessments: Market **
Table A7 – Criteria Assessments: SWOT **
Table A8 – Criteria Assessments: Other

Table A1 – Summary of intuition-based and criteria-based scores

Name	Country	ID	Cat.	Intuition-Based Scores				Criteria-Based Scores					
				Researcher 1	Researcher 2	Industry Expert	SCORE / 10	Aust. Industry Context	Sustainability	Cost / Time + Quality / Value	Market + SWOT	Other	SCORE / 10 (weighted)
MHM Solid Wood Wall	Germany	205	PC	7	8	5	6.7	3	2	1	2	2	7.0
Fort Housing System	Netherlands	214	PC PFH	7	6	6	6.3	0	2	3	1	2	6.6
Leno®-Massiv Timber Systems	Germany / Italy	207	PC	6	6	6	6.0	0	2	2	1	1	6.2
SödraSmart	Sweden	910	MISC	5	7	6	6.0	2	1	2	0	0	6.2
Carters Modular	NZ	101	PFH	5	6	6	5.7	3	2	2	1	1	6.9
Fibre Angle / Heartwood Content Measurement in Sawn Wood	Sweden	313	IW	5	7	5	5.7	3	1	2	2	1	6.9
TITAN Wood Chemical Wood Modification	UK / Netherlands	307	IW	6	5	6	5.7	3	2	2	2	1	7.1
Kebony Wood Treatment	Norway	310	IW	5	7	5	5.7	3	3	0	3	2	7.1
Tumiki House - Timber Block House	Japan	610	SS	5	7	5	5.7	3	3	2		-1	6.6
Unilogs	NZ	601	SS	5	7	5	5.7	0	1	1	-1	2	5.6
TEHA Modular Building System	Netherlands	102	PFH	5	6	6	5.7	-2	2	2	-1	1	5.3
Steko-Blocks	Switzerland	614	SS	7	7	2	5.3	2	2	1	1	2	6.6
Natwood Oil Modification	Austria	306	IW	6	5	5	5.3	2	2	2	1	2	6.8
ThermoWood	Finland	308	IW	6	6	4	5.3	2	2	1	1	1	6.4
SubstiWood	USA	406	WC	4	7	5	5.3	2	0	1	1	2	6.3
MIFS Window Socket Flashing System	USA	906	MISC	5	7	4	5.3	3	1	1	1	1	6.5
Open Prototype Initiative	USA	1001	RP	7	2	7	5.3	0	3	3	0	2	6.6
Solid Wood Elements	Norway	206	PC	6	6	4	5.3	0	2	2	1	1	6.2
Durisol Building Systems	Canada	401	WC	4	6	6	5.3	2	-1	1	2	1	6.1
Integrated Interior Infill Modules	USA	1004	RP	7	5	4	5.3	-3	1	4	0	2	5.8
Flexible Framing Track	USA	909	MISC	5	5	5	5.0	3	0	2	3	2	7.1
WoodHeart	Finland	309	IW	5	5	5	5.0	2	1	2	2	1	6.7
Greenweld	NZ	903	MISC	5	5	5	5.0	2	2	2	2	0	6.7
Wood Welding	France	1005	RP	6	6	3	5.0	2	2	1	1	2	6.6
M-Wood 2	Japan	405	WC	4	7	4	5.0	3	0	1	1	1	6.3
OSBA House Chassis	USA	1003	RP	8	3	4	5.0	-3	3	4	-2	3	5.9
Bamboo-Based Construction Products	China	908	MISC	7	2	6	5.0	1	3	0	1	0	5.9
Recycled Wood Chip Spraying - Civil Engineering Technology	Japan	914	MISC	2	7	6	5.0	2	2	0	2	-1	6.0
Lignotrend Timber Systems	Germany	204	PC	6	6	3	5.0	0	2	1	1	1	5.9
Internal Facades System	Netherlands	201	PC	5	6	4	5.0	-1	1	3	-1	0	5.5
j.Pod - Recurrent Light-Frame Building System	Japan	613	SS	7	6	2	5.0	0	0	1	1	-1	5.3
DuroWell	Switzerland	904	MISC	5	6	3	4.7	1	1	1	0	1	5.8

Table A1 – Summary of intuition-based and criteria-based scores

Name	Country	ID	Cat.	Intuition-Based Scores				Criteria-Based Scores					
				Researcher 1	Researcher 2	Industry Expert	SCORE / 10	Aust. Industry Context	Sustainability	Cost / Time + Quality / Value	Market + SWOT	Other	SCORE / 10 (weighted)
Ein Super Wood	Japan	404	WC	3	7	4	4.7	2	0	1	0	1	5.9
Massive Timber Systems Die Brettstapelbauweise	Germany	202	PC	7	5	2	4.7	0	2	1	1	1	5.9
Genetically Altered Wood	USA	303	IW	5	3	6	4.7	0	-1	0	0	0	4.8
RBS Encapsulated Building System	Canada	604	SS	4	7	3	4.7	-1	-1	0	-2	0	4.3
Quattrolit	Sweden	314	IW	3	7	3	4.3	0	1	1	1	1	5.8
GIB Braceline	NZ	606	SS	4	5	4	4.3	2	0	0	1	1	5.8
Comwood	Sweden	504	EWC	2	7	4	4.3	2	1	1	0	0	5.9
Wintec Modern Window Technology	NZ	901	MISC	2	6	5	4.3	3	1	0	1	0	6.1
Mortarless Brick Veneer	USA	801	CLI	5	4	4	4.3	2	0	0	2	1	6.0
HAL Industries INC.	Canada	803	CLI	3	4	6	4.3	1	1	0	-1	0	5.3
Wood-Polymer Lumber	USA	402	WC	2	6	4	4.0	2	-1	0	1	1	5.7
The SoundBar System	Finland	701	FL SS	4	5	3	4.0	2	1	1	0	0	5.9
Lignatur Floor Systems	Switzerland / Germany	703	FL PC	4	5	3	4.0	0	2	1	1	1	5.9
Plastic Composite Nails	USA	907	MISC	2	4	6	4.0	3	0	0	1		5.9
KAUNA PANEL	Sweden	312	IW	4	4	4	4.0	1	0	1	1	1	5.8
CELL+FUNEN	Japan	305	IW	4	3	5	4.0	2	-1	-1	2	0	5.4
Super Wall Construction Method	Japan	617	SS PC	3	6	3	4.0	2	1	-1	-2	2	5.4
ABUILD Flitches	NZ	502	EWC	3	5	4	4.0	2	-1	-1	1	0	5.3
Structural Building Systems, Inc.	USA	210	PC	4	5	3	4.0	2	0	0	-2	0	5.2
THERMAPAN	Canada	211	PC	4	5	3	4.0	2	0	0	-2	0	5.2
Pacemaker Building Systems, Inc.	USA	209	PC	4	5	3	4.0	2	-2	0	-2	0	4.8
UN Building System	Netherlands	203	PC	4	5	3	4.0	1	-2	-1	-1	1	4.7
SIMPSON Strong Tie Walls	USA	602	SS	2	7	3	4.0	1	-1	-2	-1	0	4.4
Radiant Barrier Sheathing - Plywood or OSB	USA	802	CLI	2	5	5	4.0	-2	-1	0	-2	0	4.0
SemiBjälklaget	Sweden	702	FL PC	4	5	2	3.7	1	1	1	-1	0	5.5
R-Control	USA	208	PC	2	5	4	3.7	2	-2	0	-2	0	4.8
LP Smart Side	USA	301	IW	1	6	4	3.7	-2	0	0	-1	0	4.3
ND NanoCides	USA	315	IW	3	5	2	3.3	0	1	0	0	0	5.2
Panelized Housing	USA	217	PC PFH	5	3	2	3.3	1	1	1	0	0	5.7
PULTE HOMES, INC.	USA	103	PFH	2	3	5	3.3	0	0	2	-2	-1	5.0
Hybrid Modular/Panelized Systems	USA	218	PC PFH	5	3	2	3.3	1	0	1	-2	-1	5.0
TECHNOSTRUCTURE	Japan	607	SS	3	4	3	3.3	2	0	-2	-1	1	5.0

Table A1 – Summary of intuition-based and criteria-based scores

Name	Country	ID	Cat.	Intuition-Based Scores				Criteria-Based Scores					
				Researcher 1	Researcher 2	Industry Expert	SCORE / 10	Aust. Industry Context	Sustainability	Cost / Time + Quality / Value	Market + SWOT	Other	SCORE / 10 (weighted)
GRB Jamb Tie	NZ	902	MISC	2	4	4	3.3	0	0	0	0	0	5.0
Modular Systems with SIP Panels	USA	213	PC PFH	3	5	2	3.3	-1	-1	1	-2	-1	4.3
Hinged Roofs	Netherlands	215	PC PFH	4	4	2	3.3	-2	0	0	-1	0	4.3
Timberbond Flooring	NZ	704	FL EWP	3	4	2	3.0	0	1	0	-1	0	5.0
IK METHOD - New Structure System	Japan	609	SS	3	4	2	3.0	-2	0	1	0	-1	4.6
Big Frame & ProudioBF	Japan	611	SS	3	4	2	3.0	-2	0	1	0	-1	4.6
SE Structure Method	Japan	612	SS	3	4	2	3.0	-2	0	1	0	-1	4.6
HSTPU - High Strength Timber Panel Unit	Japan	618	SS PFH	3	4	2	3.0	0	1	-1	-1	0	4.8
G-Frame Construction	Japan	608	SS	3	4	2	3.0	1	1	-2	-2	0	4.6
Ridgified Inflatable Structures	USA	1002	RP	4	3	2	3.0	-4	2	2	-3	2	4.7
Building Innovation Industries, LLC.	USA	212	PC	3	4	2	3.0	-3	-3	-2	-2	-1	2.8
Alvsbyhus	Sweeden	104	PFH	2	2	4	2.7	-2	2	2	-2	0	5.0
Kontio Loghouses	Finland	615	SS	3	3	2	2.7	-2	2	-1	-2	0	4.3
Rantasalmi Oy	Finland	616	SS	3	2	3	2.7	-2	2	-1	-2	0	4.3
Steel-Expanded Polystyrene System	USA	605	SS	2	4	2	2.7	1	0	-2	-2	-1	4.3
KARTRO LÄTTREGEL	Sweden	501	EWC	2	3	2	2.3	-1	0	-2	-2	0	3.9
Steel Stud System - TSN	USA	603	SS	2	2	3	2.3	-3	-2	-2	-2	0	3.1
Koljern	Sweeden	905	MISC	3	2	2	2.3	-2	-3	-2	-3	0	3.0
Loft Cube	Germany	105	PFH	2	2	2	2.0	-2	0	0	-1	-1	4.2
Hedalm Laft AS	Norway	106	PFH	2	2	2	2.0	-2	2	-1	-2	0	4.3
Composite Fabric Reinforced Plywood	USA	403	WC	1	2	3	2.0	-2	-1	-1	-1	0	3.9
ZIP System Roofing	USA	302	IW	1	1	4	2.0	-3	0	-3	-3	-2	2.7
Lignia Hardened Pine	NZ	304	IW	1	2	2	1.7	-2	0	-1	-1	-1	3.9
ACES	Netherlands	216	PC PFH	0	1	3	1.3	-2	1	1	-2	-1	4.4

Table A2 – Criteria Assessments: Australian Context

Name	*Score*	*Specialist skills or equipment requirements*	*Regulatory Issues*	*Network change*	*Overall fit with Australian context*
MHM Solid Wood Wall	3	minimal -may need some training, however can be installed by anyone with basic carpentry skills	minimal, just need engineering support	none if considered same as pre-nailed wall frames	very good
Fort Housing System	0	Moderate	minimal - may require some testing	moderate	unknown
Leno®-Massiv Timber Systems	0	Moderate	moderate, would require full engineering support	If the massive timber system was manufactured and used in Australia, with Australian timber, the supply chain would need to be changed due to the realisation of new factories and the transport of the elements which are upgraded in size and weight compared to present practice.	fair - it would have limited application in context of current housing methods, but offers some solutions for large open plan designs.
SödraSmart	2	might need some introduction	minimal - may require some testing	none - fits in with existing structures	good
Carters Modular	3	moderate	minimal	extensive - need a big factory area	good to excellent if directed at 'repetitious' housing markets
Fibre Angle / Heartwood Content Measurement in Sawn Wood	3	unknown	none	none	good
TITAN Wood Chemical Wood Modification	3	If a chemical industry has to be developed for manufacturing of acetylated wood in Australia, extensive skills are needed.	moderate (chemical industry)	minimal	Depends on further (scientific) development. Potentially, wood can be altered by modification in a material to be suitable for individual needs and, again potentially, it should be possible to develop the process in such a way that degradation due to insects (termites?) is avoided.
Kebony Wood Treatment	3	Moderate - the same skills as for trad. timber structures, carpenters etc.	No identified	Not identified	Very Good
Tumiki House - Timber Block House	3	none	minimal - may need some structural assessments and testing	none	excellent - for niche markets
Unilogs	0	Yes	No	minor	OK
TEHA Modular Building System	-2	moderate	moderate	moderate	fair
Steko-Blocks	2	none	minimal - may need some test	none	hard to predict, maybe niche markets
Natwood Oil Modification	2	extensive	minimal	moderate	good
ThermoWood	2	minimal in use	none	none	good
SubstiWood	2	none	none	none	excellent
MIFS Window Socket Flashing System	3	unknown	none	none	good
Open Prototype Initiative	0	Yes	Maybe	Moderate	Good
Solid Wood Elements	0	minimal/moderate	minimal - has a national technical approval from Norway based on a comprehensive full scale mechanical tests	moderate since the elements (structures) should be produced at a factory and not at building site.	fair - it would have limited application in context of current housing methods, but offers some solutions for large open plan designs.
Durisol Building Systems	2	Minimal, some training required	Would need Code Mark or similar for acceptance	producer needed	Similar to masonry block, therefore very applicable where block construction predominates such as Northern Australia.
Integrated Interior Infill Modules	-3	Yes	Yes	Yes	Yes
Flexible Framing Track	3	might need some introduction	minimal - may require some testing	none - fits in with existing structures	good
WoodHeart	2	normal glulam	none	none	good
Greenweld	2	yes	unknown	unknown	good
Wood Welding	2	Yes	Yes	Yes	Poor
M-Wood 2	3	none - can be installed by anyone with basic carpentry skills	minimal - however in some applications fire resistance may be a limiting factor eg bushfire zones, fire access and egress requirements	none	excellent / good
OSBA House Chassis	-3	Yes	Yes	Significant	Poor
Bamboo-Based Construction Products	1	none for replacement products	minimal - may require some testing	none for replacement products	good
Recycled Wood Chip Spraying - Civil Engineering Technology	2	minimal	none, assuming fire/sound ratings addressed	moderate	good

Table A2 – Criteria Assessments: Australian Context

Name	*Score*	*Specialist skills or equipment requirements*	*Regulatory Issues*	*Network change*	*Overall fit with Australian context*
Lignotrend Timber Systems	0	moderate	minimum	minimal	fits good with the Australian context, because the references which can be found on www.lignotrend.de concern one family houses, which are preferred by the Australians.
Internal Facades System	-1	Moderate	minimal - may require some testing	none - fits in with existing structures	unknown
j.Pod - Recurrent Light-Frame Building System	0	minimal - can be built by any builders who have basic training	minimal - same as usual requirements	none	good
DuroWell	1	yes	unknown	unknown	Should be very good if it has practical and commercial viability
Ein Super Wood	2	none - can be installed by anyone with basic carpentry skills	minimal - however in some applications fire resistance may be a limiting factor eg bushfire zones, fire access and egress requirements	none	excellent / good
Massive Timber Systems Die Brettstapelbauweise	0	minimal	minimal		good
Genetically Altered Wood	0	extensive	extensive	none	unknown, very long term and potential for uptake/use, not estimable at this point.
RBS Encapsulated Building System	-1	Numerous applications. Purchase production facility.	Significant	Will requires to add customer support, design support and distribution centres. Moderate to extensive.	reasonable, as similar to core filled block construction
Quattrolit	0	normal glulam	none	none	good
GIB Braceline	2	minimal	minimal	minimal	excellent
Comwood	2	Yes	none	moderate	fair
Wintec Modern Window Technology	3	moderate	minimal	minimal	good
Mortarless Brick Veneer	2	none	none	none	good
HAL Industries INC.	1	not known	minor	new product; potentially needed	good, fits within existing trade practices
Wood-Polymer Lumber	2	none	Bushfire resistance	none	excellent to good
The SoundBar System	2	none	none if testing (fire/sound) is completed	none	good
Lignatur Floor Systems	0	moderate / extensive	minimal	minimal	good
Plastic Composite Nails	3	need a special application tool	none for non-structural use	none	good
KAUNA PANEL	1	unknown	none	Not identified	unknown
CELL+FUNEN	2	none	minimal	none	potentially good
Super Wall Construction Method	2	minimal - can be installed by anyone with basic carpentry skills or may need some training to be used to it.	moderate - may need some test	minimal	Fair, would need a fundamental shift in housing delivery methods in Australia.
ABUILD Flitches	2	none - manufacturer supplies the design expertise	moderate - according to design codes	none	good, possible special areas of application
Structural Building Systems, Inc.	2	moderate	moderate (fire)	moderate to extensive	unknown
THERMAPAN	2	moderate to extensive	moderate	moderate	good
Pacemaker Building Systems, Inc.	2	moderate	moderate (fire)	moderate to extensive	limited in current context
UN Building System	1	minimum	minimum	moderate	fair
SIMPSON Strong Tie Walls	1	minimal	moderate	none	good, but limited to specialist applications.
Radiant Barrier Sheathing - Plywood or OSB	-2	none	minimal	none	Poor in context of current roofing practices. This would improve if Australia moved towards factory fabrication of housing.
SemiBjälklaget	1	none	none, if fire/sound addressed	minor	fair
R-Control	2	moderate	moderate (fire)	moderate to extensive	limited in current context
LP Smart Side	-2	none	none	none	good, but potential import competitor to local produced sheathing
ND NanoCides	0	extensive to make; minimal to use as an additive	moderate to potentially extensive	none	Neutral to good
Panelized Housing	1	none	none	significant	limited in current context
PULTE HOMES, INC.	0	none	none	may be significant depending upon supply lines	difficult to see the scale of the infrastructure required compared to the Australian context
Hybrid Modular/Panelized Systems	1	extensive	minimal	significant	a change in housing delivery systems would be required

Table A2 – Criteria Assessments: Australian Context

Name	Score	Specialist skills or equipment requirements	Regulatory Issues	Network change	Overall fit with Australian context
TECHNOSTRUCTURE	2	moderate - would need training for trades to become familiar with it	moderate - may need some testing/engineering development for Australian code requirements	none	good, the structural frame concept may fit the Australian context.
GRB Jamb Tie	0	none	some	none	good
Modular Systems With SIP Panels	-1	extensive	moderate	extensive	a change in housing delivery systems would be required
Hinged Roofs	-2	Moderate	minimal - may require some testing	none - fits in with existing structures	unknown
Timberbond Flooring	0	none - can be installed by anyone with basic carpentry skills	minimal	none	good
IK METHOD - New Structure System	-2	significant would require different skills to due to very tight construction tolerances and erection methods requiring cranes.	minimal - may require some testing in Australia plus engineering certification	minimal - all structural materials are provided by Itochu Kenzai Co., builders to get all structural materials from one company.	good
Big Frame & ProudioBF	-2	significant would require different skills to due to very tight construction tolerances and erection methods requiring cranes.	minimal - may require some testing in Australia plus engineering certification	moderate	good
SE Structure Method	-2	significant would require different skills to due to very tight construction tolerances and erection methods requiring cranes.	minimal - may require some testing in Australia plus engineering certification	moderate	good
HSTPU - High Strength Timber Panel Unit	0	moderate - may need some training to be used to it	moderate - may need some testing/engineering support	significant	Fair, would need a fundamental shift in housing delivery methods in Australia.
G-Frame Construction	1	moderate - very tight construction tolerances and new skills needed for moment resisting joints	significant as would require engineering support and certification	moderate - all structural materials have to be supplied by specific suppliers.	fair - it would have limited application in context of current housing methods, but offers some solutions for large open plan designs.
Ridgified Inflatable Structures	-4	yes	Yes	Yes	Poor
Building Innovation Industries, LLC.	-3	Factory pre-manufactured panels. Special equipment required for panel manufacturing.	Potential issues include: fire rating, sustainability.	significant	good
Alvsbyhus	-2	none, except on site crane required	none	significant	fair
Kontio Loghouses	-2	none, just basic training	some minor ones	moderate	fair
Rantasalmi Oy	-2	none, just basic training	some minor ones	moderate	fair
Steel-Expanded Polystyrene System	1	extensive	moderate	moderate	good, but definite timber threat if adopted in Australia
KARTRO LÄTTREGEL	-1	unknown	unknown	unknown	poor
Steel Stud System - TSN	-3	moderate:	minimal	moderate to extensive	poor, high labour content and complex system.
Koljern	-2	extensive	moderate	none	unknown
Loft Cube	-2	Yes, helicopters to deliver the pods	Yes, planning, fire, egress etc from high rise buildings	significant	fair
Hedalm Laft AS	-2	none, just basic training	some minor ones	moderate	fair
Composite Fabric Reinforced Plywood	-2	none in installation	minimal to moderate	none	good, but specialist applications only
ZIP System Roofing	-3	minimal	none	minimal to none	Poor in context of current roofing practices. This would improve if Australia moved towards factory fabrication of housing.
Lignia Hardened Pine	-2	none - can be used by anyone with basic woodworking skills	minimal - VOC emission under the European rating	none	good, but limited applications
ACES	-2	minimum	minimum	moderate	fits excellently with the Australian context, because most of the Australians wants to live in a one family house separates from the other houses.

Table A3 – Criteria Assessments: Sustainability

Name	*Score*	*Impact on greenhouse gas emissions*	*Impact on residential energy consumption*	*Design life expectancy*	*Renewability*	*Impact on pollution*	*Recycling implications*	*Waste implications*	*Overall Impact on Sustainability*
MHM Solid Wood Wall	2	decrease	increase	increase	definitely	reduce	good, if used in recycled composite timber products	less	good
Fort Housing System	2	reduce due to efficient factory construction	decrease	50 Years	none	none	increase	none	increase
Leno®-Massiv Timber Systems	2	decrease	decrease, because of more thermal "mass" less energy for heating and cooling is necessary	none	increase	none	increase	decrease	increase
SödraSmart	1	none - negligible impact	none	none	none	none - negligible impact	none	none	none - negligible impact
Carters Modular	2	increase	none	increased, due to materials and systems controls in the factory	none	decrease	increase	decrease	decrease
Fibre Angle / Heartwood Content Measurement in Sawn Wood	1	none	none	unknown	none	none	none	none	possible increase due to more efficient material use
TITAN Wood Chemical Wood Modification	2	none	none	increase, due to increased durability	increase (to existing; since the basic material is wood with a higher durability than untreated wood, the elements are more than completely renewable within their lifetime)	none (chemical modifications are carried out with natural products)	increased as no nasty chemicals introduced	none	increase (due to the increase of serviceability time)
Kebony Wood Treatment	3	None - no difference compared to trad. Timber - reduced if compared to conventional preservatives	None - no difference compared to trad. timber	Increase - it is expected that in areas with hard weather conditions the durability will be better compared to untreated wood. VisorWood life expectancy of at least 30 years - Kebony life expectancy of at least 45 years	Increased - It is easy to renew elements, parts, details etc.	Decrease - since the use of massive solid wood elements will accumulate carbon dioxide. The products does not contain any toxic substance or heavy metals.	None - There is no restrictions on waste materials from the products, are put in the same category as untreated timber materials.	None - there is no restrictions on waste materials, they are put in the same category as untreated timber materials.	None/Decrease - the use of FA treated wood is the same as use of a renewable resource
Tumiki House - Timber Block House	3	decrease - Using waste wood forestry thinning as material	decrease - high level of wall insulation.	none	increase	decrease	increase	decrease - Using waste wood forestry thinning as material	increase
Unilogs	1	reduce If replace steel/concrete	none	increase	possible increase if poles can be reused	reduce slightly	possible increase if poles can be reused	reduce slightly	slightly better
TEHA Modular Building System	2	none	decrease, because the overall heat insulation = 4,0 m2K/W	increase, because the details are developed in a durable way (large overhang etc.). This is suited to Northern Australian design directions.	none	none	none	none	increase, due to the energy consumption
Steko-Blocks	2	decrease - Using renewable wood	decrease	none	increase	decrease	increase	decrease - Using renewable timber	increase
Natwood Oil Modification	2	The Natwood modification process upgrades fast growing wood without the use of solvents. Therefore it effects the lifecycle contribution to greenhouse gas emission in positive manner.	none	increase, more durable timber is used.	unknown	none	increased if not a hazardous chemical	decrease if not hazardous	increase
ThermoWood	2	reduce if results in longer	none	increased	renewable	unknown	none	none	increased

Table A3 – Criteria Assessments: Sustainability

Name	*Score*	*Impact on greenhouse gas emissions*	*Impact on residential energy consumption*	*Design life expectancy*	*Renewability*	*Impact on pollution*	*Recycling implications*	*Waste implications*	*Overall Impact on Sustainability*
		life							
SubstiWood	0	decrease	none	unknown	non-renewable (cement)	unknown	unknown	unknown	negligible
MIFS Window Socket Flashing System	1	none - no difference compared to trad windows	decrease	unknown	none	none	improve	none	negligible
Open Prototype Initiative	3	Reduce	Significant reduction	significant increase	Increased	Decrease	unknown	Reduced	unknown
Solid Wood Elements	2	Decrease - the use of massive solid wood elements will accumulate carbon dioxide	None (but depend some on the out door temperature)	None/decrease - it is expected that the elements are at least as solid and durable as a traditionally timber framed house/structure.	Neutral - it depends very much of what kind of element (wall/floor/roof) and where in the structure it is sited.	Decrease - since the use of massive solid wood elements will accumulate carbon dioxide	None - the solid wood elements might be compared with glulam, and might well	None - the solid wood elements might be compared with glulam.	Decrease - the use of solid wood elements is the same as use of a renewable resource
Durisol Building Systems	-1	not known	decrease	none	none	none	increase	decrease	increase
Integrated Interior Infill Modules	1	Unknown	Unknown	Increase	Increase	Unknown	Increase	Reduced	Unknown
Flexible Framing Track	0	increase	none	unknown	increase	negligible	improved	none	negligible
WoodHeart	1	none	none	increased	unknown	none	none	none	increased
Greenweld	2	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Wood Welding	2	reduced slightly if can replace alternative connectors with wood	none	unknown	None	reduced slightly if can replace alternative connectors with wood	none	none	negligible
M-Wood 2	0	decrease	none	increase - possibly	increase	decrease/increase	decrease/increase	decrease/increase	decrease/increase
OSBA House Chassis	3	Reduce	Reduce	Increase	Increase	Decrease	Increase	Reduced	Increased
Bamboo-Based Construction Products	3	reduce	none	possible reduction unless treated	none	unknown	none	unknown	possibly significant increase
Recycled Wood Chip Spraying - Civil Engineering Technology	2	reduce, compared to steel systems	none	none	renewable	reduce	none	positive if waste products can be utilised	positive
Lignotrend Timber Systems	2	decrease	none	none to existing	increase	none	none	decrease	none
Internal Facades System	1	reduce slightly due to timber replacement of concrete	none	50 Years	increase	none	increase	none	increase slightly
j.Pod - Recurrent Light-Frame Building System	0	decrease	decrease - still developing this part	none	increase	none	increase	decrease slightly - pre-cut at factory / partly assembled at factory	increase
DuroWell	1	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Ein Super Wood	0	decrease	none	unknown	increase	decrease/increase	decrease/increase	decrease/increase	decrease/increase
Massive Timber Systems Die Brettstapelbauweise	2	decrease	none	none	increase	none	Intact beams can be used to build new elements.	Prefabrication of the elements implicate decrease of waste production.	increase
Genetically Altered Wood	-1	none	none	increase	none	none	none	none	increase
RBS Encapsulated Building System	-1	Manufacture and disposal issues	Requires good design	Perhaps an issue	decrease	PVC, concrete, etc.	decrease	increase	questionable
Quattrolit	1	none	none	increased		none	none	none	increased
GIB Braceline	0	decrease	none	none	decrease	increase	increase - looking for up cycling waste to fertilizer	decrease	increase
Comwood	1	decrease, compared to steel/spun concrete	none	unknown	renewable	decreased	recyclable	none	reduced
Wintec Modern Window Technology	1	unknown	decrease	not known	unknown	decrease if less reliance on artificial heating/cooling	decrease	decrease	increase slightly
Mortarless Brick Veneer	0	none	none	negligible compared to BV	increase	none	improved - can be re-used	decrease	improved slightly

Table A3 – Criteria Assessments: Sustainability

Name	*Score*	*Impact on greenhouse gas emissions*	*Impact on residential energy consumption*	*Design life expectancy*	*Renewability*	*Impact on pollution*	*Recycling implications*	*Waste implications*	*Overall Impact on Sustainability*
HAL Industries INC.	1	not known	not known	not known	none	unknown	none	none	increase
Wood-Polymer Lumber	-1	increase	none	increase	questionable	increase	increase	increase	not evaluated
The SoundBar System	1	slight increase	reduce	none	unknown	unknown	unknown	unknown	none - negligible impact
Lignatur Floor Systems	2	decrease	none	none	increase	none	none	decrease	none / increase
Plastic Composite Nails	0	negligible	none	increase	none	unknown	none	none	none
KAUNA PANEL	0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
CELL+FUNEN	-1	decrease	none	increase - slightly	increase slightly	none - There is no air pollution issue in the current process in production.	increase - slightly	decrease	increase
Super Wall Construction Method	1	decrease	decrease	increase	none	decrease	none	decrease - pre-cut at factory / partly assembled at factory	increase-slightly
ABUILD Flitches	-1	minimal	none	increase	increase	decrease	increase	decrease	decrease
Structural Building Systems, Inc.	0	increase	decrease	unknown	decrease	increase	decrease	increase	decrease
THERMAPAN	0	decrease	decrease	none	decrease	increase	increase	decrease	decrease
Pacemaker Building Systems, Inc.	-2	increase	decrease	unknown	decrease	increase	decrease	increase	decrease
UN Building System	-2	increase, due to the use of hard insulation (foam).	decrease (due to the high degree of isolation)	none to existing	decrease (the timber elements are within their lifetime renewable; the hard insulation however not)	increase, due to the use of hard insulation (foam).	This is an interesting point. One aspect in the development of the UN system is the opportunity to reuse elements. However, at this moment, the structural detail does not allow for this.	increase	none
SIMPSON Strong Tie Walls	-1	increase (steel)	may increase (see above) or none	none	none or decrease (steel)	increase (steel)	none	none	decrease (marginally)
Radiant Barrier Sheathing - Plywood or OSB	-1	increase	decrease	increase	none	none	none	none	increase
SemiBjälklaget	1	reduce, compared to steel/concrete systems	none	none	renewable	reduce	none	unknown	positive
R-Control	-2	increase	decrease	unknown	decrease	increase	decrease	increase	decrease
LP Smart Side	0	none	none	increase	increase	decrease	none	none	None
ND NanoCides	1	increase	increase	increase	none	none	none	none	Slightly positive
Panelized Housing	1	increase	none	none	none	none	none	decrease	increase
PULTE HOMES, INC.	0	none	none	none	N/A	N/A	increase	decrease	increase
Hybrid Modular/Panelized Systems	0	decrease	none	none	none	none	increase	decrease	increase
TECHNOSTRUCTURE	0	decrease	decrease	increase	none	decrease - pre-cut at factory / partly assembled at factory	increase slightly - using steel	decrease - pre-cut at factory / partly assembled at factory	increase-slightly
GRB Jamb Tie	0	negligible	none	negligible	none	negligible	none	none	negligible
Modular Systems With SIP Panels	-1	decrease	decrease	none	decrease	increase	decrease	increase	decrease
Hinged Roofs	0	neutral	none	50 Years	increase	none	increase	none	increase
Timberbond Flooring	1	increase than concrete	none, reduce if used for ground floors	none	increase	decrease	increase	none	decrease
IK METHOD - New Structure System	0	decrease slightly	decrease slightly	increase - IK Method is flexible framework.	increase	none	increase - large section sizes and ease of de-construction	decrease - pre-cut at factory / partly assembled at factory	increase - slightly
Big Frame & ProudioBF	0	decrease	decrease	increase	increase	decrease	increase - large section	decrease - pre cut at	increase

Table A3 – Criteria Assessments: Sustainability

Name	*Score*	*Impact on greenhouse gas emissions*	*Impact on residential energy consumption*	*Design life expectancy*	*Renewability*	*Impact on pollution*	*Recycling implications*	*Waste implications*	*Overall Impact on Sustainability*
							sizes and ease of de-construction	factory / partly assembled at factory	
SE Structure Method	0	decrease slightly - none for this structural method itself but at the material production stage, it is slightly effective.	none	increase	increase slightly	decrease	increase - large section sizes and ease of de-construction	decrease - pre-cut at factory / partly assembled at factory	increase - slightly
HSTPU - High Strength Timber Panel Unit	1	decrease	decrease	increase	none	decrease - pre-cut at factory / partly assembled at factory	none	decrease - pre-cut at factory / partly assembled at factory	increase-slightly
G-Frame Construction	1	decrease	none	increase	none	decrease - slightly	improved due to large sections and ease of de-construction	decrease - pre-cut at factory / partly assembled at factory	increase - slightly
Ridgified Inflatable Structures	2	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Building Innovation Industries, LLC.	-3	Questionable. The recycling will require specialized facilities (separation of materials, processes to recycle the polymeric foam). Production of gasses in manufacturing of the steel and foam are likely to exceed those in lumber manufacturing.	Decrease or none. This will depend on the individual design (R-value can be controlled by wall dimensions).	No information available.	None.	Increase.	None.	Decrease.	Decrease.
Alvsbyhus	2	decrease	none	normal	increase	reduce	none	reduced	increased
Kontio Loghouses	2	reduce	reduce	long	renewable	decrease	none	none	positive
Rantasalmi Oy	2	reduce	reduce	long	renewable	decrease	none	none	positive
Steel-Expanded Polystyrene System	0	increase	reduce	increase	decrease	increase	decrease	decrease	decrease
KARTRO LÄTTREGEL	0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Steel Stud System - TSN	-2	increase	increase	increase	decrease	increase	none	decrease	decrease
Koljern	-3	unknown	none	unknown	none	none	none	unknown	none
Loft Cube	0	none	Unknown	unknown	unknown	unknown	unknown	unknown	unknown
Hedalm Laft AS	2	reduce	reduce	long	renewable	decrease	none	none	positive
Composite Fabric Reinforced Plywood	-1	increase	none	increase	decrease	increase	decrease	none	decrease
ZIP System Roofing	0	none	none	none	no change	none	none	none	none
Lignia Hardened Pine	0	not available	none	increase	increase - radiata pine more renewable than tropical hardwood	increase - use of chemicals	none	increase - low chemical content	decrease - timber from managed plantation
ACES	1	increase, due to the use of hard insulation (foam).	decrease (due to the high degree of isolation)	none to existing	none	increase, due to the use of hard insulation (foam).	none	increase	none

Table A4 – Criteria Assessments: Costs

Name	*Score*	*Impact on Costs - LABOUR*	*Impact on Costs – OH&S*	*Impact on Costs - MATERIALS*	*Impact on Costs – LIFE CYCLE*	*Impact on Costs - EQUIPMENT*	*impact on costs - OVERALL*
MHM Solid Wood Wall	1	reduce	none	increase	reduce	increase, as cranes required	unknown
Fort Housing System	3	Decrease	none	none	Decrease	Increase	Decrease
Leno®-Massiv Timber Systems	2	Decrease	Decrease	increase	none	increase	none
SödraSmart	2	unknown	none	unknown	none	none	unknown
Carters Modular	2	decrease	decrease	decrease	decrease	increase	decrease
Fibre Angle / Heartwood Content Measurement in Sawn Wood	2	unknown	unknown	unknown	unknown	unknown	unknown
TITAN Wood Chemical Wood Modification	2	none	increase	increase; extra attention has to be paid to connectors (in several cases inox is needed) (Col: what is Inox)	decrease	none	decrease
Kebony Wood Treatment	0	None - the use of FA treated wood is the same as use of untreated wood.	None - the use of FA treated wood is the same as use of untreated wood.	Increase - FA treated wood is more expensive than untreated wood.	Decrease - longer lifetime than for untreated wood, maintenance free	None - compared to the use of untreated timber.	Increase - but depends some on the time perspective and the need of renew untreated materials.
Tumiki House - Timber Block House	2	decrease - the owner can build it by themselves	none	none	none	none	decrease
Unilogs	1	none	unknown	reduce compared to steel/concrete	Unknown	none	reduce slightly
TEHA Modular Building System	2	decrease due to the very high degree of prefabrication	reduced	probably increased due to high levels of insulation	none	none	probably increase in Australian context
Steko-Blocks	1	decrease - the owner can build it by themselves	none	none	none	none	decrease
Natwood Oil Modification	2	none	none	decrease	decrease	none	none
ThermoWood	1	none	none	increase	unknown	none	unknown
SubstiWood	1	unknown	unknown	unknown	unknown	unknown	unknown
MIFS Window Socket Flashing System	1	reduce	unknown	increase	unknown	unknown	increase
Open Prototype Initiative	3	unknown	unknown	unknown	reduced due to increased durability and reusability	Increase	Increased
Solid Wood Elements	2	none	Decrease due to faster assembling of the structure/house	Normally none compared with traditional timber frame building	Increase slightly - depends very much on the structure.	None	None
Durisol Building Systems	1	none	none	probably increase	decrease	plant required	increase
Integrated Interior Infill Modules	4	Reduce	Reduced	Increased	Unknown	Increase	Unknown
Flexible Framing Track	2	decrease slightly due to faster construction	none	increase slightly - a little more expensive than all-wood alternative	unknown	none	increase slightly
WoodHeart	2	none	none	increase	unknown	none	increase
Greenweld	2	unknown	unknown	unknown	unknown	unknown	unknown
Wood Welding	1	Reduce	none	increased	unknown	Increase	increase compared to current practice
M-Wood 2	1	none	none	increase	not known	none	increase
OSBA House Chassis	4	Reduce	Reduced	Increased	Reduced?	Increase	Increase
Bamboo-Based Construction Products	0	none	none	potential reduction	unknown	unknown	reduce
Recycled Wood Chip Spraying - Civil Engineering Technology	0	reduce	none	increase	decrease	none	increase
Lignotrend Timber Systems	1	none	none	increase	none	increase as site cranage required	none
Internal Facades System	3	Decrease	none	none	Decrease	Increase	Decrease
j.Pod - Recurrent Light-Frame Building System	1	decrease - due to faster construction	none	increase	decrease	increase if cranes required	increase
DuroWell	1	unknown	unknown	unknown	unknown	unknown	unknown
Ein Super Wood	1	none	none	increase	not known	none	increase

Table A4 – Criteria Assessments: Costs

Name	Score	Impact on Costs - LABOUR	Impact on Costs – OH&S	Impact on Costs - MATERIALS	Impact on Costs – LIFE CYCLE	Impact on Costs - EQUIPMENT	impact on costs - OVERALL
Massive Timber Systems Die Brettstapelbauweise	1	decrease	none	none/increase	none	increase as site cranage required	none
Genetically Altered Wood	0	none	none	decrease	none	none	decrease
RBS Encapsulated Building System	0	decrease	Increase in some cases	Increase	increase	increase	Increase in some cases
Quattrolit	1	none	none	increase	unknown	none	increase
GIB Braceline	0	none	none	none	none	none	none
Comwood	1	none	none	increased over normal timber	unknown	unknown	increase
Wintec Modern Window Technology	0	decrease	increase	increase	none	none	increase
Mortarless Brick Veneer	0	decrease, can be installed by anyone with basic skills	none	no mortar needed- decrease	reduce slightly because of potential replacement	no mortar equipment needed- decrease	decrease
HAL Industries INC.	0	increase	increase	increase	decrease	none	increase
Wood-Polymer Lumber	0	none	none	increase	decrease	none	none
The SoundBar System	1	increase	none	increase	unknown	none	slight increase
Lignatur Floor Systems	1	decrease	none	increase	none	increase as site cranage required	decrease
Plastic Composite Nails	0	none	none	increase	unknown	increase	unknown
KAUNA PANEL	1	unknown	unknown	unknown	unknown	unknown	unknown
CELL+FUNEN	-1	none	none	increase slightly - a little more expensive than natural timber without any treatment	none	none	none - product cost will increase but maybe offset by new market opportunities or reduced active fire control requirements under building regulations
Super Wall Construction Method	-1	none	none	none	none	increase, as cranes required	increase
ABUILD Flitches	-1	none	none	decrease or increase depending upon application	decrease	decrease	unknown
Structural Building Systems, Inc.	0	decrease	increase	increase	none	none	increase
THERMAPAN	0	decrease	none	increase	unknown	none	none to increase
Pacemaker Building Systems, Inc.	0	decrease	increase	increase	none	none	increase
UN Building System	-1	decrease due to the high degree of prefabrication and rationality	decrease due to the high degree of prefabrication and rationality	increase, due to the choice to have just one basic element for all (inner- and outer walls, floors and roof)	decrease due to the high degree of prefabrication and rationality	none	probably increase in Australian context
SIMPSON Strong Tie Walls	-2	increase	none	increase	none	none	increase
Radiant Barrier Sheathing - Plywood or OSB	0	none	reduce	increase	none	none	increase
SemiBjälklaget	1	unknown	none	increase	decrease	none	increase
R-Control	0	decrease	increase	increase	none	none	increase
LP Smart Side	0	depends on what we are comparing the technology with; none	none	increase (overlay, preservative)	none	none	slight increase
ND NanoCides	0	none	none	increase	not known	increase	increase
Panelized Housing	1	decrease	decrease	decrease	none	none	decrease
PULTE HOMES, INC.	2	decrease	decrease	decrease	decrease	increase	decrease
Hybrid Modular/Panelized Systems	1	decrease	decrease	decrease	none	increase	decrease
TECHNOSTRUCTURE	-2	decrease slightly - however, this company says that it is unable to compare it simply.	reduced if partial factory fabrication occurs	increase	none	increase due to crane requirements	increase
GRB Jamb Tie	0	none	none	increase	none	none	increase
Modular Systems With SIP Panels	1	decrease	none	increase	none	increase	decrease
Hinged Roofs	0	Decrease	none	none	Decrease	Increase	Decrease
Timberbond Flooring	0	decrease	none	increase	decrease	increase where cranes required	increase
IK METHOD - New Structure System	1	decrease	none	increase slightly	none	none	none
Big Frame & ProudioBF	1	decrease - due to faster	none	increase slightly	none	none or decrease slightly	none or decrease slightly

Table A4 – Criteria Assessments: Costs

Name	*Score*	*Impact on Costs - LABOUR*	*Impact on Costs – OH&S*	*Impact on Costs - MATERIALS*	*Impact on Costs – LIFE CYCLE*	*Impact on Costs - EQUIPMENT*	*impact on costs - OVERALL*
		construction					
SE Structure Method	1	decrease	none	increase - slightly	none	none	none
HSTPU - High Strength Timber Panel Unit	-1	decrease slightly - due to faster construction	reduced due to partial factory fabrication	increase due to 'heavy' post and beam and extra sheathing	none	none	none
G-Frame Construction	-2	increase	none	increase	none	increase as will require lifting equipment	increase
Ridgified Inflatable Structures	2	reduced	unknown	reduced	unknown	increase	reduce
Building Innovation Industries, LLC.	-2	Decrease. On-site labour demand will decrease due to the panellized system	None.	Increase.	No information available.	Increase.	Increase.
Alvsbyhus	2	reduced on-site - transferred to factory	reduced	none	reduced	reduced	reduced
Kontio Loghouses	-1	probably reduce	none	increase	none	none	increase
Rantasalmi Oy	-1	probably reduce	none	increase	none	none	increase
Steel-Expanded Polystyrene System	-2	increase	unknown	increase	decrease	increase	increase
KARTRO LÄTTREGEL	-2	unknown	unknown	unknown	unknown	unknown	unknown
Steel Stud System - TSN	-2	increase	none	increase	none	increase	increase
Koljern	-2	unknown	unknown	unknown	unknown	unknown	unknown
Loft Cube	0	unknown	unknown	unknown	unknown	unknown	unknown
Hedalm Laft AS	-1	probably reduce	none	increase	none	none	increase
Composite Fabric Reinforced Plywood	-1	none	none	increase	increase	none	increase
ZIP System Roofing	-3	increase	improved for roof fixers	significant increase	none	none	significant increase
Lignia Hardened Pine	-1	none	increase slightly due to formaldehyde resin	increase	decrease	none	decrease
ACES	1	decrease due to the high degree of prefabrication	decrease due to the high degree of prefabrication	none	none	none	decrease due to the high degree of prefabrication

Table A5 – Criteria Assessments: Quality / Time / Value

Name	*Score*	Impact on construction quality	Impact on construction time	Impact on % timber product volume	Impact on % timber product value
MHM Solid Wood Wall	1	none	none	increase markedly	potential increase
Fort Housing System	3	Increase	Decrease	Increase	Increase
Leno®-Massiv Timber Systems	2	increase	decrease	increase	increase
SödraSmart	2	negligible	unknown	negligible	increase
Carters Modular	2	increase	decrease	increased, compared to traditional on-site construction methods	increase
Fibre Angle / Heartwood Content Measurement in Sawn Wood	2	unknown	unknown	unknown	unknown
TITAN Wood Chemical Wood Modification	2	none	none	increase (due to the reduction in strength properties)	increase
Kebony Wood Treatment	0	None impact on the basic structure, but over time the durability of the structure is increased.	None - compared to the use of untreated timber.	Increase - properties of the products allows for the use applications/constructions were traditional untreated timber is not recommended used.	Increase - since the possibility of reuse is higher.
Tumiki House - Timber Block House	2	none	decrease - whenever and wherever a lot of people can lay these timber blocks at the same time, and it makes possible to reduce the construction time.	increase	increase
Unilogs	1	none	none	increase	increase
TEHA Modular Building System	2	increase, due to the minimum of actions to be carried out on the building site	decrease due to the very high degree of prefabrication	none	none
Steko-Blocks	1	none	decrease - wherever a lot of people can lay these timber blocks at the same time, it reduces the construction time.	increase	increase
Natwood Oil Modification	2	none	none	none	increase
ThermoWood	1	unknown	none	increase	increase
SubstiWood	1	unknown	unknown	increase if replaces normal masonry	increased for waste timber
MIFS Window Socket Flashing System	1	increase slightly	reduce	none	none
Open Prototype Initiative	3	Increased	Deceased	None	None
Solid Wood Elements	2	Indeterminable, it depends on what kind of elements used (wall and/or floor and/or roof), species and/or material quality/grade of the different layers, rate of detailing and/or additional furnishing etc.	Indeterminable, it depends on what kind of elements used (wall and/or floor and/or roof) and in what kind of structure they are used. But generally an increase because of good bracing effects and possibilities of bigger floorage without need for any support.	Decrease	Increase - but ow much will depends very on the structure and where the elements are used (wall and/or floor and/or roof).
Durisol Building Systems	1	increase	decrease	increase, if replaces masonry blocks	none
Integrated Interior Infill Modules	4	Increase	Reduced	Unknown	Unknown
Flexible Framing Track	2	increase slightly - will improve the accuracy of member positioning	decrease slightly	reduce slightly because of metal substitution	none or maybe slight decrease - reduced timber volume may be offset by increased attractiveness
WoodHeart	2	increase	none	increase if replaces competitive materials such as steel	increase
Greenweld	2	unknown	unknown	unknown	unknown
Wood Welding	1	increase	Reduced	slight increase	increase
M-Wood 2	1	increase	decrease	decrease	increase
OSBA House Chassis	4	Increase	Decrease	Reduce	Reduce
Bamboo-Based Construction Products	0	unknown	none	reduce	reduce
Recycled Wood Chip Spraying - Civil Engineering Technology	0	increase	reduce	increase	increase
Lignotrend Timber Systems	1	none	none	increase	increase
Internal Facades System	3	Increase	Decrease	Increase	Increase
j.Pod - Recurrent Light-Frame Building System	1	increase	decrease	increase	increase

Table A5 – Criteria Assessments: Quality / Time / Value

Name	*Score*	Impact on construction quality	Impact on construction time	Impact on % timber product volume	Impact on % timber product value
DuroWell	1	unknown	unknown	unknown	unknown
Ein Super Wood	1	increase	none	decrease	increase
Massive Timber Systems Die Brettstapelbauweise	1	increase	decrease	increase	increase
Genetically Altered Wood	0	none	none	increase	
RBS Encapsulated Building System	0	Greatly improved	Greatly improved	decrease	decrease
Quattrolit	1	increase	none	increase if replaces competitive materials such as steel	increase
GIB Braceline	0	increase	none	decrease	decrease
Comwood	1	increase	none	increase if replaces competitive steel etc	increase
Wintec Modern Window Technology	0	increase	decrease	none	none
Mortarless Brick Veneer	0	may improve quality	reduce compared to traditional masonry	none	none
HAL Industries INC.	0	increase	increase	none	increase
Wood-Polymer Lumber	0	none	none	decrease	increase
The SoundBar System	1	increase	none	none	increase
Lignatur Floor Systems	1	increase	decrease	increase	increase
Plastic Composite Nails	0	none	none	none	none
KAUNA PANEL	1	unknown	unknown	unknown	unknown
CELL+FUNEN	-1	increase	none	increase	increase
Super Wall Construction Method	-1	increase	decrease	increase slightly	increase slightly
ABUILD Flitches	-1	none	decrease	decrease	increase
Structural Building Systems, Inc.	0	increase	decrease	decrease	none
THERMAPAN	0	increase	decrease	decrease	none
Pacemaker Building Systems, Inc.	0	increase	decrease	decrease	none
UN Building System	-1	none / increase (basic principle for the development)	decrease due to the high degree of prefabrication and rationality	increase, due to the choice to have just one basic element for all (inner- and outer walls, floors and roof)	increase, due to the choice to have just one basic element for all (inner- and outer walls, floors and roof)
SIMPSON Strong Tie Walls	-2	increase	none	none	unknown
Radiant Barrier Sheathing - Plywood or OSB	0	increase	increase	increase	increase
SemiBjälklaget	1	increase	reduce	increase	increase
R-Control	0	increase	decrease	decrease	none
LP Smart Side	0	none	none compared to other strip siding	increase	increase
ND NanoCides	0	increase	none	none	increase
Panelized Housing	1	increase	decrease	none	none
PULTE HOMES, INC.	2	increase	decrease	increase	increase
Hybrid Modular/Panelized Systems	1	increase	decrease	none	none
TECHNOSTRUCTURE	-2	increase	decrease	decrease slightly - using steel beams instead of timber	increase
GRB Jamb Tie	0	none	none	none	none
Modular Systems With SIP Panels	1	increase	decrease	decrease	increase
Hinged Roofs	0	Increase	Decrease	Increase	Increase
Timberbond Flooring	0	increase (less shrinkage)	decrease	increase	increase
IK METHOD - New Structure System	1	increase	decrease	increase	increase - can design & build larger spans using this method
Big Frame & ProudioBF	1	increase	decrease slightly	increase	increase
SE Structure Method	1	increase	decrease	increase slightly	increase
HSTPU - High Strength Timber Panel Unit	-1	increase	decrease slightly due to the panel unit system	increase slightly	increase slightly
G-Frame Construction	-2	increase	increase - need some additional preparation time on site	increase - slightly	increase
Ridgified Inflatable Structures	2	unknown	reduce	reduce	reduce

Table A5 – Criteria Assessments: Quality / Time / Value

Name	*Score*	Impact on construction quality	Impact on construction time	Impact on % timber product volume	Impact on % timber product value
Building Innovation Industries, LLC.	-2	Increase.	Decrease. On-site labour demand will decrease due to the panellized system	Decrease.	None.
Alvsbyhus	2	increased	reduced	increased	increased
Kontio Loghouses	-1	none	decrease	increase	increase
Rantasalmi Oy	-1	none	decrease	increase	increase
Steel-Expanded Polystyrene System	-2	increase	increase	decrease	decrease
KARTRO LÄTTREGEL	-2	unknown	unknown	unknown	unknown
Steel Stud System - TSN	-2	increase	none	decrease	none
Koljern	-2	unknown	reduce	none	none
Loft Cube	0	unknown	unknown	unknown	unknown
Hedalm Laft AS	-1	none	decrease	increase	increase
Composite Fabric Reinforced Plywood	-1	increase	none	none	increase
ZIP System Roofing	-3	increase	increase	increase	increase
Lignia Hardened Pine	-1	increase - dimensional stability	none	none	increase - good way for radiata pine to compete with hardwood in some specialist applications
ACES	1	none / increase (basic principle for the development)	decrease due to the high degree of prefabrication	none	none

Table A6 – Criteria Assessments: Market

Name	Score	Barriers to entry	Effort required to penetrate market and realize returns	Technical complexity	Product Support Requirements
MHM Solid Wood Wall	2	minimal	moderate	simple	unknown
Fort Housing System	1	minimal	moderate	intermediate	moderate
Leno®-Massiv Timber Systems	1	moderate	significant	intermediate	moderate
SödraSmart	0	moderate	moderate	minor	minimal
Carters Modular	1	minimal	moderate	intermediate	minimal
Fibre Angle / Heartwood Content Measurement in Sawn Wood	2	unknown	unknown	unknown	unknown
TITAN Wood Chemical Wood Modification	2	moderate	moderate	intermediate	none
Kebony Wood Treatment	3	Minimal if durability/costs are proven	Minimal if durability/costs are proven	None	Moderate - mainly in the form of plain and convincing technical documentation.
Tumiki House - Timber Block House		minimal - consumer perceptions, structural integrity & fire regulations	moderate	moderate	minimal - basic documentation
Unilogs	-1	minimal	moderate	low	low
TEHA Modular Building System	-1	moderate	significant	intermediate (due to the very high level of prefabrication)	moderate (marketing)
Steko-Blocks	1	Not a "typical Australian" approach to building. May need intense marketing.	Carpenters need to be informed and somehow interested.. Huge effort?	radical	minimal - basic documentation
Natwood Oil Modification	1	moderate, the process is patent registered.	moderate	intermediate	moderate
ThermoWood	1	minimal	minimal - fits in with existing practices	minor	minimal
SubstiWood	1	minimal	minimal	low	unknown
MIFS Window Socket Flashing System	1	moderate	moderate	moderate	unknown
Open Prototype Initiative	0	unknown	unknown	unknown	unknown
Solid Wood Elements	1	Increase - Low grade/quality timber might be used in inner layers without (almost) any negative effects on the element's high strength and stiffness quality.	Moderate - because of resistance against and/or fear of new and unknown methods and/or materials.	Moderate - mainly technical documentation in the form of user-friendly easily accessible predefined details (e.g. drawings, design, calculation models etc.). Advantageous to have an official and/or national Technical Approval based on national/prevailing standards, specifications and/or regulations.	Moderate - mainly technical documentation in the form of user-friendly easily accessible predefined details (e.g. drawings, design, calculation models etc.).
Durisol Building Systems	2	capital investment	moderate to extensive	moderate	moderate
Integrated Interior Infill Modules	0	unknown	unknown	unknown	unknown
Flexible Framing Track	3	minimal - fits in with existing practices	minimal - fits in with existing practices	incremental - variation on traditional construction	minimal - basic documentation
WoodHeart	2	minimal	moderate	minor	minimal
Greenweld	2	unknown	unknown	unknown	unknown
Wood Welding	1	unknown	unknown	unknown	unknown
M-Wood 2	1	minimal - need to explain to users the characteristics and how to use	minimal - need to explain to users the characteristics and how to use	How to install the product - radical / Production technology - incremental	minimal - basic documentation
OSBA House Chassis	-2	unknown	unknown	unknown	unknown
Bamboo-Based Construction Products	1	minimal if equivalent performance for lower cost	minimal	low	none
Recycled Wood Chip Spraying - Civil Engineering Technology	2	unknown	unknown	unknown	unknown
Lignotrend Timber Systems	1	moderate	moderate	intermediate	minimal
Internal Facades System	-1	minimal	moderate	intermediate	moderate
j.Pod - Recurrent Light-Frame Building System	1	moderate - still developing	moderate - j.Pod is a new building system so that it needs to be promoted	moderate	minimal - basic documents & trainings

Table A6 – Criteria Assessments: Market

Name	Score	Barriers to entry	Effort required to penetrate market and realize returns	Technical complexity	Product Support Requirements
DuroWell	0	unknown	unknown	unknown	unknown
Ein Super Wood	0	minimal - need to reduce the price	none	radical - how to install the product / incremental - its production technology	minimal - basic documentation
Massive Timber Systems Die Brettstapelbauweise	1	minimal	minimal	incremental	minimal
Genetically Altered Wood	0	unknown	none once available	radical	none
RBS Encapsulated Building System	-2	moderate	moderate	intermediate	minimal
Quattrolit	1	minimal	moderate	minor	minimal
GIB Braceline	1	minimal - good gypsum source	minimal - fits in with existing practices	incremental	minimal
Comwood	0	cost	moderate	minimal	engineering required
Wintec Modern Window Technology	1	unknown	unknown	unknown	unknown
Mortarless Brick Veneer	2	style/appearance	minimal - fits in with existing practices	simple	minimal - basic documentation
HAL Industries INC.	-1	new product	moderate	incremental	minimal
Wood-Polymer Lumber	1	minimal	minimal to moderate	incremental	moderate
The SoundBar System	0	minimal, just cost	minimal - fits in with existing practices	minor	minimal
Lignatur Floor Systems	1	moderate	moderate	intermediate	minimal
Plastic Composite Nails	1	moderate - requires new equipment	minimal - fits in with existing practices	moderate	minimal - basic documentation
KAUNA PANEL	1	unknown	unknown	unknown	unknown
CELL+FUNEN	2	minimal - the additional cost	minimal - cost	minimal	minimal - basic documents
Super Wall Construction Method	-2	none in Japan / moderate in Australia - new construction method	minimal in Japan / moderate in Australia	radical in Japan / intermediate in Australia	moderate - basic documentation and training
ABUILD Flitches	1	moderate	minimal	moderate	minimal
Structural Building Systems, Inc.	-2	considerable in current context	moderate to extensive	incremental	moderate to extensive
THERMAPAN	-2	considerable in current context	moderate	incremental	moderate
Pacemaker Building Systems, Inc.	-2	considerable in current context	moderate to extensive	incremental	moderate to extensive
UN Building System	-1	minimal	minimal	incremental	moderate (marketing)
SIMPSON Strong Tie Walls	-1	minimal	moderate	incremental	moderate
Radiant Barrier Sheathing - Plywood or OSB	-2	moderate	significant	incremental	minimal
SemiBjälklaget	-1	moderate	moderate	minor	minimal
R-Control	-2	considerable in current context	moderate to extensive	incremental	moderate to extensive
LP Smart Side	-1	none	minimal	incremental	minimal
ND NanoCides	0	moderate but not yet known	minimal	incremental	minimal
Panelized Housing	0	considerable in current context, would require philosophical change to current sub-contractor housing delivery system.	significant	incremental	none
PULTE HOMES, INC.	-2	market acceptance, design inflexibility	moderate, once established	N/A	none
Hybrid Modular/Panelized Systems	-2	moderate	extensive	moderate	minimal
TECHNOSTRUCTURE	-1	moderate	moderate in Australia	intermediate	moderate - basic documentation / training
GRB Jamb Tie	0	low	moderate	low	none
Modular Systems With SIP Panels	-2	moderate	moderate to extensive	intermediate	moderate
Hinged Roofs	-1	minimal	moderate	intermediate	moderate
Timberbond Flooring	-1	minimal	moderate	minimal	moderate
IK METHOD - New Structure	0	moderate in Australia - it is a new structural	significant	moderate	minimal - basic documentation & some training

Table A6 – Criteria Assessments: Market

Name	Score	Barriers to entry	Effort required to penetrate market and realize returns	Technical complexity	Product Support Requirements
System		system/construction method so that it may need some tests, training and certification in Australia. Cost will also be an issue.			
Big Frame & ProudioBF	0	moderate in Australia - it is a new structural system/construction method so that it may need some tests, training and certification in Australia. Cost will also be an issue.	significant	moderate	basic documents & training
SE Structure Method	0	moderate in Australia - it is a new structural system/construction method so that it may need some tests, training and certification in Australia. Cost will also be an issue.	significant	moderate	moderate - structural calculation / structural drawings / trainings
HSTPU - High Strength Timber Panel Unit	-1	moderate	moderate - need to have acceptance of factory fabricated housing and familiarisation	radical in Japan / intermediate in Australia due to a new construction method	minimal - basic documents / training
G-Frame Construction	-2	moderate as new technology and increased cost	moderate	radical for construction & building / intermediate for design works - need extra structural calculations	moderate - structure calculation / some specific drawing
Ridgified Inflatable Structures	-3	unknown	unknown	unknown	unknown
Building Innovation Industries, LLC.	-2	significant, philosophical change required	significant	Intermediate.	Extensive.
Alvsbyhus	-2	moderate	significant	minimal	unknown
Kontio Loghouses	-2	limited markets	moderate	simple	minimal
Rantasalmi Oy	-2	limited markets	moderate	simple	minimal
Steel-Expanded Polystyrene System	-2	moderate to high	moderate to extensive	intermediate	extensive
KARTRO LÄTTREGEL	-2	unknown	unknown	unknown	unknown
Steel Stud System - TSN	-2	moderate	moderate	intermediate	moderate
Koljern	-3	minimal	minimal	intermediate	minimal
Loft Cube	-1	significant	significant	unknown	unknown
Hedalm Laft AS	-2	limited markets	moderate	simple	minimal
Composite Fabric Reinforced Plywood	-1	minimal	minimal	incremental	minimal to moderate
ZIP System Roofing	-3	significant	significant	incremental	minimal
Lignia Hardened Pine	-1	moderate - price competitiveness depends on radiata's price and hardwood's price	moderate - need high volume of sales to compete with hardwood market	intermediate - intensive research concerning chemicals has been done	minimal
ACES	-2	minimal	minimal	incremental	moderate (marketing)

Table A7 – Criteria Assessments: SWOT

Name	Score	Strengths	Weaknesses	Opportunities	Threats
MHM Solid Wood Wall	2	energy efficiency, sustainable, solid, fire resistance sound reductions	termites, cost, durability	all housing	competitive systems
Fort Housing System	1	Quick design and delivery system.	cost		Long distance transportation in Australian circumstances
Leno®-Massiv Timber Systems	1	"Whole house solution", prefabricated, effective use of timber. Better in house climate.	Cost. Massive floor causes lack of space for plumbing/drainage facilities. Location of other services.	Potential for utilisation of large volumes of low grade pine	alternative products
SödraSmart	0	alternative to steel, sustainable	cost, acceptability in commercial sector	high rise partitions	steel, cost
Carters Modular	1	Potential for cost, time and quality efficiencies	modification on the initial designs is not economically feasible	commercial building, hostel company, market with lot of units of the same design	not enough units or a too small panel
Fibre Angle / Heartwood Content Measurement in Sawn Wood	2	unknown	unknown	unknown	unknown
TITAN Wood Chemical Wood Modification	2	increase in durability; decrease of shrinkage and swelling which results in an increase of the life performance of finishing (painting)	chemical process	see strengths, if fire performance can be improved may have potential for use in bushfire prone areas	acceptance
Kebony Wood Treatment	3	The treated product (FA treated wood) is a environmentally friendly timber products produced of a renewable organic resource (biomass waste). The treated product can be used in the same way as untreated wood. The treated product will under normal conditions (regarding weather, climate, natural environment etc.) have a higher durability than untreated timber, may be even as high as timber treated by heavy metal preservatives.	The material costs are higher than untreated timber.	FA treated timber might be used at the same areas where timber treated with heavy metal preservatives earlier were used, without any negative environmentally influence and with high degree of durability.	Conservatism regarding new building methods and materials. Building site carpenters and construction workers. Concrete elements and producers of such. Use of listed timber species. Harvesting timber in environmentally damaging way i.e. get the environmentalists as opponents instead of as supporters. Rigid regulations regarding fire protection might prevent or reduce some applications of solid timber elements.
Tumiki House - Timber Block House		Easy to build houses using this system; easy to manufacture, adopt and establish. Tumiki House is Ecofriendly.	Fire regulations, weatherproofing and structural integrity	Rapid temporary housing, DIY and niche markets	alternative construction systems
Unilogs	-1	lightweight alternative to steel or concrete	lack of experience in use and complications in attachments. Chemical treatment of poles	light industrial and multi-storey residential	steel and concrete alternatives
TEHA Modular Building System	-1	high degree of prefabrication	You have to convince the market about the high quality realised with a composition of "units"	Townhouses, flats, mining camps and repetitious construction	cost and also see "Weaknesses"
Steko-Blocks	1	Easy to build houses using this system; Easy to manufacture, adopt/bring in, easy to design	market acceptance	replacement of traditional construction systems	alternative construction systems
Natwood Oil Modification	1	Cheap, environmental friendly, easy to use, no change of supply/use chain needed	Increasing brittleness, under patent.	An alternative to preservative treatment of timber	alternative treatment technologies
ThermoWood	1	non-chemical durability and stability improvement	real data supporting long term performance	cladding, decking and other external uses for pine	claimed properties in Australian climatic context
SubstiWood	1	potential replacement for a range of construction products	limited experience in use	replacement products for reinforced and unreinforced masonry. Potential in future as a replacement for structural timber products	competition from other products
MIFS Window Socket Flashing System	1	better system to seal openings	cost, existing window door industry competition	see strengths	traditional products
Open Prototype Initiative	0	unknown	unknown	unknown	unknown

Table A7 – Criteria Assessments: SWOT

Name	Score	Strengths	Weaknesses	Opportunities	Threats
Solid Wood Elements	1	Solid timber elements are produced of a renewable resource which accumulate carbondioxide. The necessary assembling time at building site is short and just a small mobile crane is required to handle the elements. Elements are fit for reuse or might be used as an environmentally friendly energy resource through waste incineration if condemned. The elements can utilise non-structural timber to be a part of high quality structural timber elements. The elements might be used in the same way as concrete elements, but are more easy to handle because of the much lower weight. The elements give the architects possibilities/challenges regarding use of treated and/or untreated timber surfaces.	Must be produced at a purpose built factory plant, which might bring some logistical challenges regarding distance to the building site. The element production must meet high requirements regarding precision. If the gluing between the different laminations/layers (bond line) are imperfect, e.g. because of poor gluing skill and/or inaccuracy regarding lamination thickness, the strength capacity of the elements will have a drastically reduction. The elements are sensitive to moisture/water during assembling at the building site. Poor design of relevant details might give problems regarding sound control/propagation between adjacent rooms and/or flats. It is also important to claim attention to the rolling-shear capacity between the cross laminated layers/laminations.	Increasing the timber product volume. Utilising non-structural timber in a high quality structural element. Be an exciting and challenging structural material regarding architects. Gain an increasing market share based on sustainability, renewable resources and green consumerism.	Conservatism regarding new building methods and materials. Building site carpenters and construction workers. Concrete elements and producers of such. Use of listed timber species. Harvesting timber in environmentally damaging way i.e. get the environmentalists as opponents instead of as supporters. Rigid regulations regarding fire protection might prevent or reduce some applications of solid timber elements. Rigid regulations regarding emissions, toxic or not, to indoor spaces might reduce some applications of solid timber elements.
Durisol Building Systems	2	energy efficient system; use of wood waste material	use of concrete requires curing times in production; product acceptance	energy savings; fire and insect resistant systems	capital investment
Integrated Interior Infill Modules	0	unknown	unknown	unknown	unknown
Flexible Framing Track	3	fits in well with existing practices and industry structure; Facilitates architectural diversity;	only applicable to site-constructed frames;	Increasing DIY market; Architects -desire for complex architectural forms;	shift to off-site manufactured frames;
WoodHeart	2	increased durability	cost, stability to moisture change	verandah posts etc	steel, hardwood
Greenweld	2	unknown	unknown	unknown	unknown
Wood Welding	1	unknown	unknown	unknown	unknown
M-Wood 2	1	Eco & Recycle product	Need to give more explanations about the product features to builders & owners than using existing materials. Because this product is new building materials and some people are familiar and some are not.	M-Wood 2 is produced by extraction moulding at the moment and this company is going to develop " Injection moulding & Casting" to expand to other markets.	competition with similar products - other companies provide similar products which are cheaper and poor quality.
OSBA House Chassis	-2	unknown	unknown	unknown	unknown
Bamboo-Based Construction Products	1	Eco-friendly and potentially cheaper than timber products	lyctine susceptible	timber replacement at all levels, niche eco developments	alternative products
Recycled Wood Chip Spraying - Civil Engineering Technology	2	unknown	unknown	unknown	unknown
Lignotrend Timber Systems	1	low shrinkage and swelling due to glued cross layers	Cost	Alternative to 'I' joist and truss joist floor systems	supply
Internal Facades System	-1	Faster construction times	Only applicable in combination with loadbearing concrete or block work walls. Requires heavy lifting equipment	replace 'front' and 'back' walls in tilt-up structures	Long distance transportation in Australian circumstances
j.Pod - Recurrent Light-Frame Building System	1	easy to build / sustainable / more simple and stronger - earthquake-resistant structure / eco-friendly / can be built wherever & whenever / can use local materials(timber) & builders	j.Pod development group have not yet establish the methods for manufacture big quantities, how to store these and the sales system. Need to develop the flexibility of design.	There is the possibility in all market.	need to train architects & builders to be familiar with j.Pod. Building regulations for new a construction method may need to be addressed.
DuroWell	0	unknown	unknown	unknown	unknown
Ein Super Wood	0	eco & recycle product / long life cycle - this product/material can be used/produced repeatedly.	the price & fire resistance	existing timber market	competition with similar products - other companies provide similar products which are cheaper and poor quality.
Massive Timber Systems Die Brettstapelbauweise	1	Flexible in use, large spans possible, prefabricated.	Cost. No space for plumbing in floor, swelling and shrinking of timber can be visible.	Alternative to 'I' joist and truss joist floor systems	alternative products
Genetically Altered Wood	0	improved quality and efficiency of forest industry	unproven	higher quality and lower cost products	unknown
RBS Encapsulated Building System	-2	Speed, completeness, mould, seismic, wind, HAM controlled	Cost, Plastic use	See above	environmental issues
Quattrolit	1	increased durability	cost, stability to moisture change	verandah posts etc	steel, hardwood
GIB Braceline	1	similar technology to existing bracing products with better sound and fire resistant proprieties	product from a no renewable source	as a replacement for withdrawn plasterboard bracing, noise and fire resistance	have to consider the energy expense

Table A7 – Criteria Assessments: SWOT

Name	Score	Strengths	Weaknesses	Opportunities	Threats
Comwood	0	aesthetics	durability, cost	street landscape furniture	steel, durability
Wintec Modern Window Technology	1	unknown	unknown	unknown	unknown
Mortarless Brick Veneer	2	fast, easy, same results	unknown market acceptability	replacement of alternative cladding systems	alternative products
HAL Industries INC.	-1	stiffness, versatility	added costs	replace sheathing	costs
Wood-Polymer Lumber	1	Using recycled material may have marketing advantage. Decay resistant.	Recycling problem is shifted towards the customers.	replace alterative products	alternative products
The SoundBar System	0	good sound attenuation for impact/structure borne	cost	multi-residential	
Lignatur Floor Systems	1	Prefabricated, flexible, knowledge is available, hollow system.	Cost	Alternative to 'I' joist and truss joist floor systems	alternative products
Plastic Composite Nails	1	will not rust	not very strong: not for structural use	limited	normal nails
KAUNA PANEL	1	unknown	unknown	unknown	unknown
CELL+FUNEN	2	Potential for new timber markets and value adding	More expensive than timber without this treatment treatment is water-soluble.	Building components that require fire rating or reduced combustibility attributes.	Costs, limited application
Super Wall Construction Method	-2	Super Wall construction method enables builders to build uniform & high quality houses	The internal layout of houses using this system might be less flexible than other new structure methods.	New housing system	competition with similar type of building systems.
ABUILD Flitches	1	Adaptable, engineered product	renovation is currently a small market	renovation, and new construction.	engineering error with damage, too small market
Structural Building Systems, Inc.	-2	energy efficient system; potentially fact erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise the integrity of the building envelope.	energy efficient system; potentially fast erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise
THERMAPAN	-2	fast erection times; better quality control due to the industrially manufactured panels, energy efficient	the use of insulating foam increases environmental load; potential toxicity in case of a fire; system is sensitive to connection details	energy efficient systems; rapid construction times; complete panels	acceptance by the construction community and public; no sufficient data on durability
Pacemaker Building Systems, Inc.	-2	energy efficient system; potentially fast erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise the integrity of the building envelope.	energy efficient system; potentially fast erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise
UN Building System	-1	high degree of prefabrication and rationality	one basic element for all (inner- and outer walls, floors and roof), resulting in a design based on the most hazardous "loaded" element.	Due to the high degree of prefabrication and rationality, the opportunities may be limited in the Australian context	Solving all detailing problems and "problems" with implementing computer aided design and computer aided manufacturing in the most efficient way.
SIMPSON Strong Tie Walls	-1	permits application where narrow walls are required and relatively large lateral forces need to be transmitted (hurricane prone-areas, e.g.)	requires pre-manufacturing and special hardware to attach	narrow wall bracing; improvement in lateral load resistance in application where space is a limitation	license probably needed - this may increase costs
Radiant Barrier Sheathing - Plywood or OSB	-2	energy efficient solution; simple system that integrates the reflective radiant barrier and mechanical system	will require more delicate manipulation during delivery and on the construction site. additional materials, costs and labour in the Australian context.	energy efficient buildings	costs, change in practices
SemiBjälklaget	-1	alternative to steel, sustainable	cost, acceptability in commercial sector	multi-residential/commercial floors	cost, concrete
R-Control	-2	energy efficient system; potentially fast erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise the integrity of the building envelope.	energy efficient system; potentially fast erection times	use of plastic (fire resistance; environmental friendliness; recyclability); connections between panels and the panels and other structural members and parts of the system are non-standard; penetrations for the HVAC and electrical installations may compromise
LP Smart Side	-1	wood product, easiness in installation	does not have sufficient track record; will still shrink and swell with change in moisture contents	using renewable and recyclable timber product	OSB siding does not have a good name in the US and this is a barrier to overcome. May still exhibit deterioration when subjected to severe weather conditions.

Table A7 – Criteria Assessments: SWOT

Name	Score	Strengths	Weaknesses	Opportunities	Threats
ND NanoCides	0	Powder-like nanocapsules can be added during existing manufacturing process (of what?). The laboratory tests showed effectiveness of the system.	It is not clear how long the inhibiting system will be effective (repeating mould attack).	New, emerging technology. If successful, will enhance the durability of wood products.	Unknown health hazard issues - none according to the inventor - but will have to be independently confirmed.
Panelized Housing	0	panellized systems minimize the waste (in-factory panel manufacturing; better quality control	need for good organization of the construction process	urban communities and fast developing communities; efficient product delivery	poor construction process organization will lead to losses
PULTE HOMES, INC.	-2	this is a business system that permits quality control; efficient design; utilising prefabricated systems and mass production features	This model needs relatively large and growing market and mostly suitable for urban areas.	Efficiency and cost effectiveness.	Need for large initial capital
Hybrid Modular/Panelized Systems	-2	Hybrid/modular system permit better quality control and increase construction efficiency. Elements/subsystems are pre-manufactured in the factory and assembled on-site. The assembly times are shorter and this decreases costs in markets where labour costs are high. Despite panellized approach these systems can be flexible in designs and floor plans.	Need to invest in the factory equipment. Light construction equipment (such as light crane) are needed at the construction site. Efficient construction processes organization is critical.	Better quality control of the final product. Waste minimization - the waste is concentrated in the plant and can be efficiently processed. This has positive environmental impact.	Increase in oil prices may result in increased costs of the final product due to the transportation costs. Probably not efficient in rural areas.
TECHNOSTRUCTURE	-1	Technostructure enables builders to build uniform & high quality houses / high earthquake-resistant	cost and a new system	detached houses and similar structures	competition with similar type of building systems - a construction system of whole house.
GRB Jamb Tie	0	easier construction	extra cost	limited	traditional practices
Modular Systems With SIP Panels	-2	More efficient than the panellized system using lumber. The system can be more efficient in the factory environment due to the prefabricated walls.	Using plastic (foam) increases environmental pressure. Recyclebility is questionable. Fire performance is questionable - the plastic may exhaust toxic fumes during fire. Residuals from manufacturing and construction process may be difficult to recycle.	Efficient panellized/modular construction system with high insulation parameters. Structurally stiff plates can be manufactured. Combination with other materials such as reflective layers, vapour barriers, metal layers. etc. can create additional opportunities.	Using plastic may result in high energy demand during manufacturing. Unclear recycling of the panel residuals.
Hinged Roofs	-1	speedy construction	Requires heavy lifting equipment	replacement of simple shaped roofs	Long distance transportation in Australian circumstances
Timberbond Flooring	-1	very versatile, improved energy efficiency, sound/fire performance etc	lack of technical support	solves technical span/depth limitations and adds design flexibility and lightness compared to concrete slabs	unknown product, difficult to handle without lifting equipment and certainly an acoustic problem without additional acoustic design
IK METHOD - New Structure System	0	Flexibility of internal layout design, high-durability and long-lasting. The high-precision and high-speed construction features of this method thus enable us to provide highly functional wooden housing at a low cost.	Material cost is more expensive than existing timber structures. Very tight construction tolerances.	Increasing use of timber in other types of building markets such as commercial construction	Competition with similar technology
Big Frame & ProudioBF	0	It enables a long-life house for many generations / flexible internal layout / super high strength / high durability	Material cost is more expensive than existing timber structures. Very tight construction tolerances.	all / existing timber structure frame market	Competition with similar technology
SE Structure Method	0	Quality is secured (guaranteed) / Structure performance is proved scientifically. / SE Structural Method enables the flexibility of internal layout design, high-durability and long-lasting. It provides high quality management technology for safety. SE Structure Method is stronger than existing timber structure. It enables large-size buildings to be constructed.	There is little interest by general consumers for this method. It is a little bit difficult for general consumers to understand SE Structural Method, because it is technical, so needs explanation about the advantages of this structural method.	all market	competition with similar technology
HSTPU - High Strength Timber Panel Unit	-1	HSTPU enables builders to build uniform & high quality houses	Costs, design flexibility	New housing system	competition with similar type of building systems - a construction system of whole house.
G-Frame Construction	-2	G-Frame provides opportunities for large open plan living in combination with 'light' frame construction	cost and additional design work	Provides solutions for large open plan style housing	competition with similar technologies
Ridgified Inflatable Structures	-3	unknown	unknown	unknown	unknown
Building Innovation Industries, LLC.	-2	Factory produced panellized system allows for better quality control. Increase in construction speed can be significant. Non-biodegradable materials (insect and fungi) permit use in hazard environments.	High energy demand in material manufacturing. Need to train workers - new construction process.	Fast construction. System not susceptible to fungi and insect attacks. Rapid erection.	Acceptance by design professionals. Code compliance will need to be clarified.

Table A7 – Criteria Assessments: SWOT

Name	Score	Strengths	Weaknesses	Opportunities	Threats
Alvsbyhus	-2	high degree of prefabrication	market acceptance	replace or combine with traditional methods	Market size and competition from conventional housing
Kontio Loghouses	-2	niche market	limited market, may need bigger numbers to make economical	holiday cabins	traditional construction
Rantasalmi Oy	-2	niche market	limited market, may need bigger numbers to make economical	holiday cabins	traditional construction
Steel-Expanded Polystyrene System	-2	Relatively robust construction system. Panels are insect and decay resistant and can be manufactured with high level of consistency in performance (steel and polystyrene).	Construction details may be difficult. Workforce will require training. The system is using non-renewable materials production of which will increase CO2 emissions. Negative impact on the LCA results.	Termite sensitive areas.	Material and construction costs.
KARTRO LÄTTREGEL	-2	unknown	unknown	unknown	unknown
Steel Stud System - TSN	-2	details are worked out; prefabricated parts will minimize waste	labour intensive on site compared to typical wood framing	alternative systems; more consistent product	increase energy costs and steel costs
Koljern	-3	high quality connection technique without mechanical fasteners	Patented (International Patent Nr. PCT/CH02/00711)	see strengths	It might never be used in the future due to investments for the necessary equipment.
Loft Cube	-1	use of existing space	need suitable rooftop space	Niche inner city housing	unknown
Hedalm Laft AS	-2	niche market	limited market, may need bigger numbers to make economical	holiday cabins	alternative products
Composite Fabric Reinforced Plywood	-1	increase load-bearing capacity	costs	high-wind risk areas	costs
ZIP System Roofing	-3	Improved OH&S and structural adequacy of roofs	Costs, time etc	Suited to factory fabrication of roof systems	Product acceptance - increased product price is offset by decreased costs but the economics will depend on local market.
Lignia Hardened Pine	-1	variety of colours available	high cost of suitable quality radiata stock	an impressive alternative to hardwood	low hardwood price, high radiata price and low volume sale
ACES	-2	high degree of prefabrication	"low" fire resistance due to the light weight elements and the materials used (hard board and PE isolation)	Due to the high degree of prefabrication, the opportunities are good	fire resistance

Table A8 – Criteria Assessments: Other

Name	Score	Impact on style and attractiveness	Impact on durability	Impact on OHS	Impact on fire resistance	Impact on acoustic performance	Impact on structural performance / robustness	Impact on indoor air quality
MHM Solid Wood Wall	2	none	none if done correctly	none	increase	increase	increase	none, but they say better
Fort Housing System	2	Good, great variety possible.	none	none	Limited	none	increase, due to prefabrication control.	none
Leno®-Massiv Timber Systems	1	extensive	none	none	increase	increase	increase	increase
SödraSmart	0	none	none	improve due to ease of service installation	possible reduction	negligible	reduce slightly	none
Carters Modular	1	moderate	increase due to control of materials and detailing etc	increase	none	none	increase	none
Fibre Angle / Heartwood Content Measurement in Sawn Wood	1	none	unknown	none	none	none	negligible	none
TITAN Wood Chemical Wood Modification	1	none	increase	none	unknown	none	decrease	the "after treatment" is very important to reduce the chemicals used and, consequently, to avoid unpleasant smell. However, since only natural chemicals are used, no health threatening residues remain.
Kebony Wood Treatment	2	Moderate - it depends on the designers and architects, is possible to realise constructions where untreated wood is not suitable to use	Increase - VisorWood 30 years - Kebony 45 years	None - the method and/or product itself do not influence on OHS	None	None	None - the impact strength is decreased but this property does normally not influence much on a structure's performance/robustness	None/Increase - compared to non FA treated wood the impact is none. The impact from formaldehyde and VOC's will be less than for untreated timber.
Tumiki House - Timber Block House	-1	moderate	none	none	none	none	none - needs evaluation and assessment	none
Unilogs	2	none	none - poles are treated	none	unknown	none	unknown	none
TEHA Modular Building System	1	minimal / moderate	none	increase	The system is well tested regarding fire resistance, which is reported to be high.	none	increase	none
Steko-Blocks	2	moderate	increase	unknown	unknown	none	increase	none
Natwood Oil Modification	2	minimal	none	none	unknown, maybe a positive if improves fire properties.	none	none	none
ThermoWood	1	none	increase	none, but non-chemical may be a plus at industrial level	unknown	none	reduced	none
SubstiWood	2	none	increase	none	increase	unknown	increase over unreinforced masonry	none
MIFS Window Socket Flashing System	1	none	improved	negligible	none	none	negligible	none
Open Prototype Initiative	2	None	Increase	Increase - potentially	Increase - potentially	Increase - potentially	Increase - potentially	Increase - potentially
Solid Wood Elements	1	None / minimal / moderate / extensive - it depends on the designers and architects.	None / increase / decrease - it depends on design of details of structural protection regarding biological attack, weathering and other effects that affect the durability of timber structures.	None - the method and/or product itself do not influence on OHS	Increase - compared with traditional timber structures/houses. This because of the compact cross section the fire characteristics (reaction to fire, charring rate etc.) of the elements are improved, which also have been proved during full scale fire tests of the elements.	None (to decreased sound transmission) - provided that necessary sound reducing efforts/detailing are thorough accomplished. Carelessness during this work might however increase potential problems regarded sound and sound transmission.	none - negligible impact	Increase - Both the timber surfaces itself and the glue will submit some amount formaldehyde. Dependent on the species, timber also submit some amounts of terpenes. Dependent on the VOC definition (VOC, TVOC etc.) these terepenes (and some other VOCs) will influence on the VOC value. However the grade of impact

Table A8 – Criteria Assessments: Other

Name	Score	Impact on style and attractiveness	Impact on durability	Impact on OHS	Impact on fire resistance	Impact on acoustic performance	Impact on structural performance / robustness	Impact on indoor air quality
								on indoor air quality must be evaluated in proportion to the chosen VOC-definition.
Durisol Building Systems	1	none	none	none	increase	increase	increase	not known
Integrated Interior Infill Modules	2	Subjective	unknown	unknown	unknown	unknown	unknown	unknown
Flexible Framing Track	2	moderate - will help build more complex shapes on site	none - may be very minor corrosion issue when in contact with concrete, can be overcome with good detailing using a moisture barrier	none	none	none	unknown	none
WoodHeart	1	none	increase	none	none	none	none	none
Greenweld	0	none	unknown	none	none	none	none	none
Wood Welding	2	None	unknown - possible reduction	negligible	unknown - possible reduction	none	unknown - possible reduction where ductility required	increased air quality if less gluing is needed
M-Wood 2	1	extensive	increase	none	may have limited application in bushfire prone areas	none	none	none
OSBA House Chassis	3	Subjective	Increase if 'chassis' can be adequately protected	unknown	unknown	unknown	none	unknown
Bamboo-Based Construction Products	0	none	decrease unless treated properly	none	unknown	none	negligible	depends on product and glues and treatments used
Recycled Wood Chip Spraying - Civil Engineering Technology	-1	none	none	none	none	none	none	none
Lignotrend Timber Systems	1	May be extensive due to the "timber outlook" of the building	none	none	none	none	increase, due to glued plate elements	none
Internal Facades System	0	Limited, only flat facades possible	none	negligible	Limited	none	none	none
j.Pod - Recurrent Light-Frame Building System	-1	moderate - the structural system & the concept of this method are excellent, however need to address design flexibility.	none	none	none	none	increase	increase
DuroWell	1	none	unknown	none	none	none	none	none
Ein Super Wood	1	extensive	increase	none	may have limited application in bushfire prone areas	none	none	none
Massive Timber Systems Die Brettstapelbauweise	1	moderate	none	none	none	none/decrease	increase	increase
Genetically Altered Wood	0	none	potential increase	none	none	none	none	none
RBS Encapsulated Building System	0	moderate	probably increase but use of plastic may make it questionable	none	plastic may create issues	increase	Increase—relative to wood frame	none
Quattrolit	1	none	increase	none	none	none	none	none
GIB Braceline	1	moderate	increase	none	increase	increase	increase	none
Comwood	0	moderate	none - internal	none	possible reduction but depends on application	none	none	negative - glued product
Wintec Modern Window Technology	0	none	none	none	none	increase	unknown	none
Mortarless Brick Veneer	1	none	similar to brick veneer	none	none	none	same as other bricklaying, maybe better	none
HAL Industries INC.	0	none	increase	none	none	none	increase	none
Wood-Polymer Lumber	1	increased	increased	none	decrease for bushfire	none	decrease on mass/mass basis	none

Table A8 – Criteria Assessments: Other

Name	Score	Impact on style and attractiveness	Impact on durability	Impact on OHS	Impact on fire resistance	Impact on acoustic performance	Impact on structural performance / robustness	Impact on indoor air quality
The SoundBar System	0	none	none	none	increase	significant increase	none	none
Lignatur Floor Systems	1	extensive	none	none	none	none / decrease	increase	increase
Plastic Composite Nails	0	none	increase	none	none	none	reduced	none
KAUNA PANEL	1	minimal	unknown	unknown	unknown	unknown	unknown	none
CELL+FUNEN	0	extensive	increase	none	increase	none	increase	increase - no formaldehyde,
Super Wall Construction Method	2	moderate	increase, except for weather exposed timber	none	increase	increase	increase	increase
ABUILD Flitches	0	minimal - some steel reinforcing may be visible	none	none	none	none	increase	none
Structural Building Systems, Inc.	0	none	potential increase	none	questionable; plastic will result in toxic fumes in case of fire	increase	increase	unknown
THERMAPAN	0	none	none	none	none	increase	increase but depends on other design factors	none - see fire considerations
Pacemaker Building Systems, Inc.	0	none	potential increase	none	questionable; plastic will result in toxic fumes in case of fire	increase	increase	unknown
UN Building System	1	minimal	none	increase	none	decrease (a very light weight structure; same basic acoustic performance as any structure based on the SIPS technology)	none	none
SIMPSON Strong Tie Walls	0	none	none	none	none	none	increase	none
Radiant Barrier Sheathing - Plywood or OSB	0	none	increase	none	none	increase	none	none
SemiBjälklaget	0	none	reduce versus concrete	none	none	none	none	none
R-Control	0	none	potential increase	none	questionable; plastic will result in toxic fumes in case of fire	increase	increase	unknown
LP Smart Side	0	none; may actually increase - painting	should increase compared to typical hardboard siding	none	decrease	none	none	none
ND NanoCides	0	none	increase	none, but needs independent verification	none	none	none	increase
Panelized Housing	0	none	none	none	none	none	none	none
PULTE HOMES, INC.	-1	none	increase	significant if off-site prefabricated	none	none	none	none
Hybrid Modular/Panelized Systems	-1	limited design flexibility	none	none	none	none	none	none
TECHNOSTRUCTURE	1	moderate	increase - Technostructure method is a construction system of the whole house.	none	increase	increase	increase	increase
GRB Jamb Tie	0	none	none	none	none	none	none	none
Modular Systems With SIP Panels	-1	none	none or increase	none	none	increase	increase	none but may be negative - depending on the adhesive systems needed to bond the individual layers
Hinged Roofs	0	Limited, only straight forward pitched roofs possible.	none	positive	Limited	none	none	none
Timberbond Flooring	0	moderate	none	none	decrease or increase depending upon what being compared to.	decrease or increase depending upon what being compared to.	increase - excellent span/depth ratio	none
IK METHOD - New Structure System	-1	moderate - more flexible internal layout than existing timber structure methods	increase	may need specialist erection equipment	increased	none	increase	none

Table A8 – Criteria Assessments: Other

Name	Score	Impact on style and attractiveness	Impact on durability	Impact on OHS	Impact on fire resistance	Impact on acoustic performance	Impact on structural performance / robustness	Impact on indoor air quality
Big Frame & ProudioBF	-1	extensive - this structural system enables long-life houses for many generations. Skeleton/infill concept and high fluidity reflect the likelihood of future renovations.	increase	may need specialist erection equipment	increased	increase - ProudioBF	increase	none
SE Structure Method	-1	extensive - more flexible internal layout than existing timber structural method / enables large-sized building e.g. stadiums / gymnasiums / halls	increase	may need specialist erection equipment	increased	none	increase	none
HSTPU - High Strength Timber Panel Unit	0	moderate	increase	none	increase	increase	increase	increase slightly
G-Frame Construction	0	moderate	increase	none	increase - G-Frame (large-section laminated-timber) has high fire resistance.	none	increase	none
Ridgified Inflatable Structures	2	extensive	unknown	unknown	unknown	unknown	unknown	unknown
Building Innovation Industries, LLC.	-1	moderate	increase	none	increase but potential for a release of toxic gasses during fire	increase or none	increase but no experimental data available	none
Alvsbyhus	0	very limited	increased	improved	none	none	improved	none
Kontio Loghouses	0	extensive	increase	unknown	unknown	improved	none, but improved impact resistance	unknown
Rantasalmi Oy	0	extensive	increase	unknown	unknown	improved	none, but improved impact resistance	unknown
Steel-Expanded Polystyrene System	-1	none	increase	none	may not increase	unknown	increase	none
KARTRO LÄTTREGEL	0	unknown	unknown	unknown	unknown	unknown	unknown	none
Steel Stud System - TSN	0	none	increase	none	increase	none	none	none
Koljern	0	unknown	unknown	unknown	unknown	unknown	unknown	none
Loft Cube	-1	moderate	unknown	increase	unknown	unknown	none, but loads and wind/tie-down issues would need to be addressed	none
Hedalm Laft AS	0	moderate	possible increase	increase	unknown	unknown	none, but improved impact resistance	none
Composite Fabric Reinforced Plywood	0	none	increase	none	none	none	increase	none
ZIP System Roofing	-2	none	none	improve as provides a platform for roof fixers	none	none	none	none
Lignia Hardened Pine	-1	extensive - looks like hardwood, really attractive	increase	increase due to formaldehyde resin	increase	none	increase	decrease - because of VOC
ACES	-1	minimal	none	none	the system in itself does not affect the fire resistance. However, as mentioned before, the fire resistance is negatively influenced by the light weight and the materials used.	decrease (a very light weight structure; same basic acoustic performance as any structure based on the SIPS technology)	increase, due to prefabrication control.	none

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