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Secondary Use of Timber

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Cascading principle

- Using wood more efficiently to meet projected demand for wood-based products in Europe should be at the heart of the European Commission's bioenergy strategy and circular economy.
- "*Cascading use of wood is the smart way to use a natural resource – putting it to good use before it is reused, recycled and finally burnt for energy. Taking wood straight from the forest and burning it just doesn't make sense if it can be used for other products first*", says Peter Oswald, CEO Mondi Europe and International.

Source: WWF. (2016). *Cascading use of wood products*. https://www.wwf.eu/?263091/Cascading-use-of-wood-products-report

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Cascading types

Cascading Use

"Cascading use of biomass takes place when biomass is processed into a bio-based final product and this final product is utilised at least once more either for material use or energy."

Single-stage cascade

"Cascading use of biomass is described as single-stage, when the bio-based final product is directly used for energy."

Multi-stage cascade

"Cascading use of biomass is described as multi-stage when biomass is processed into a bio-based final product and this final product is used at least once more as a material. This means that in order to be counted as a multi-stage cascade, at least two material uses need to have occurred before the energy use."

Source: WWF. (2016). *Cascading use of wood products*. https://www.wwf.eu/?263091/Cascading-use-of-wood-products-report

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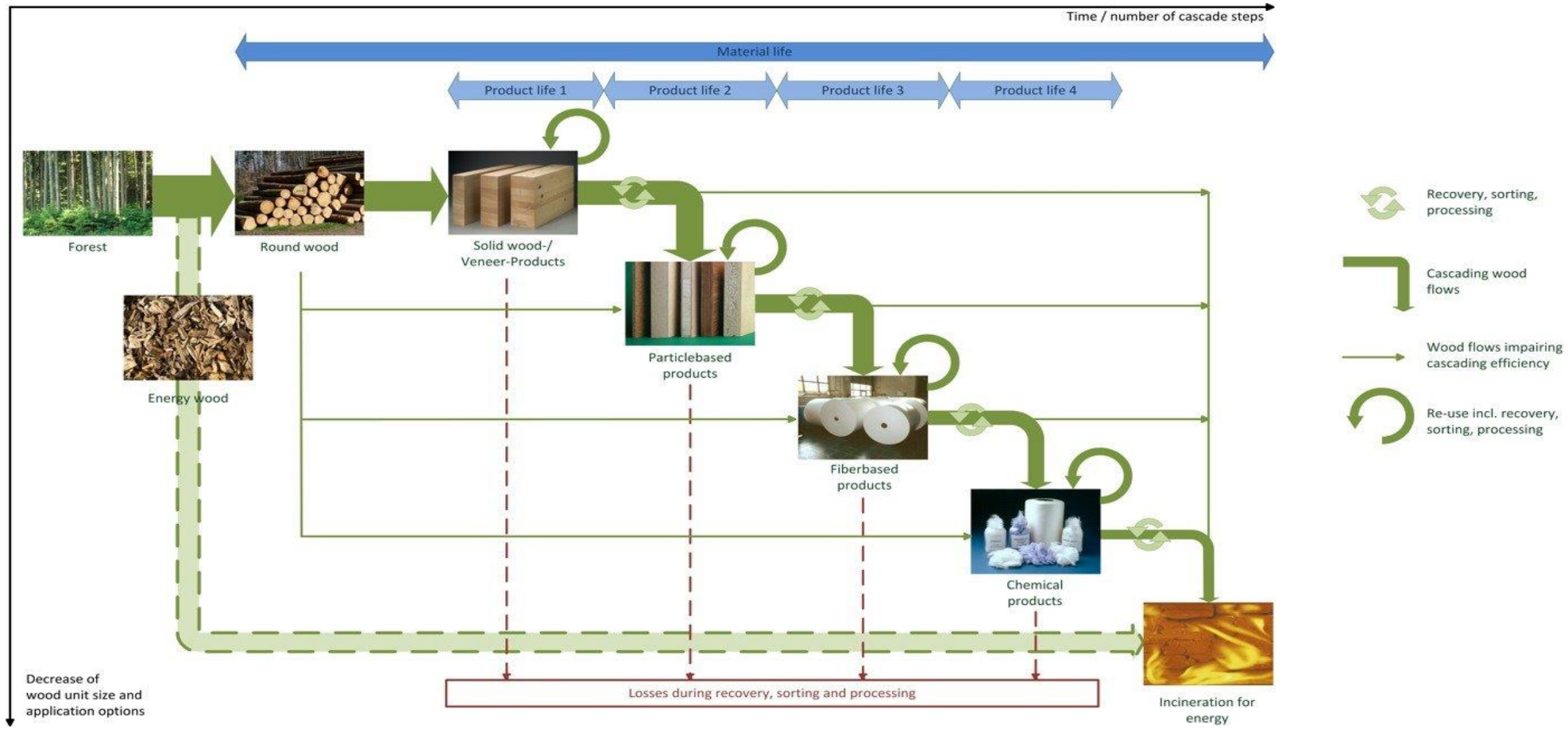
Multi-stage cascade



Source: Technical University Munich. (2017). *Cascading use of wood to ensure sustainability*. https://phys.org/news/2017-12-cascading-wood-sustainability.html

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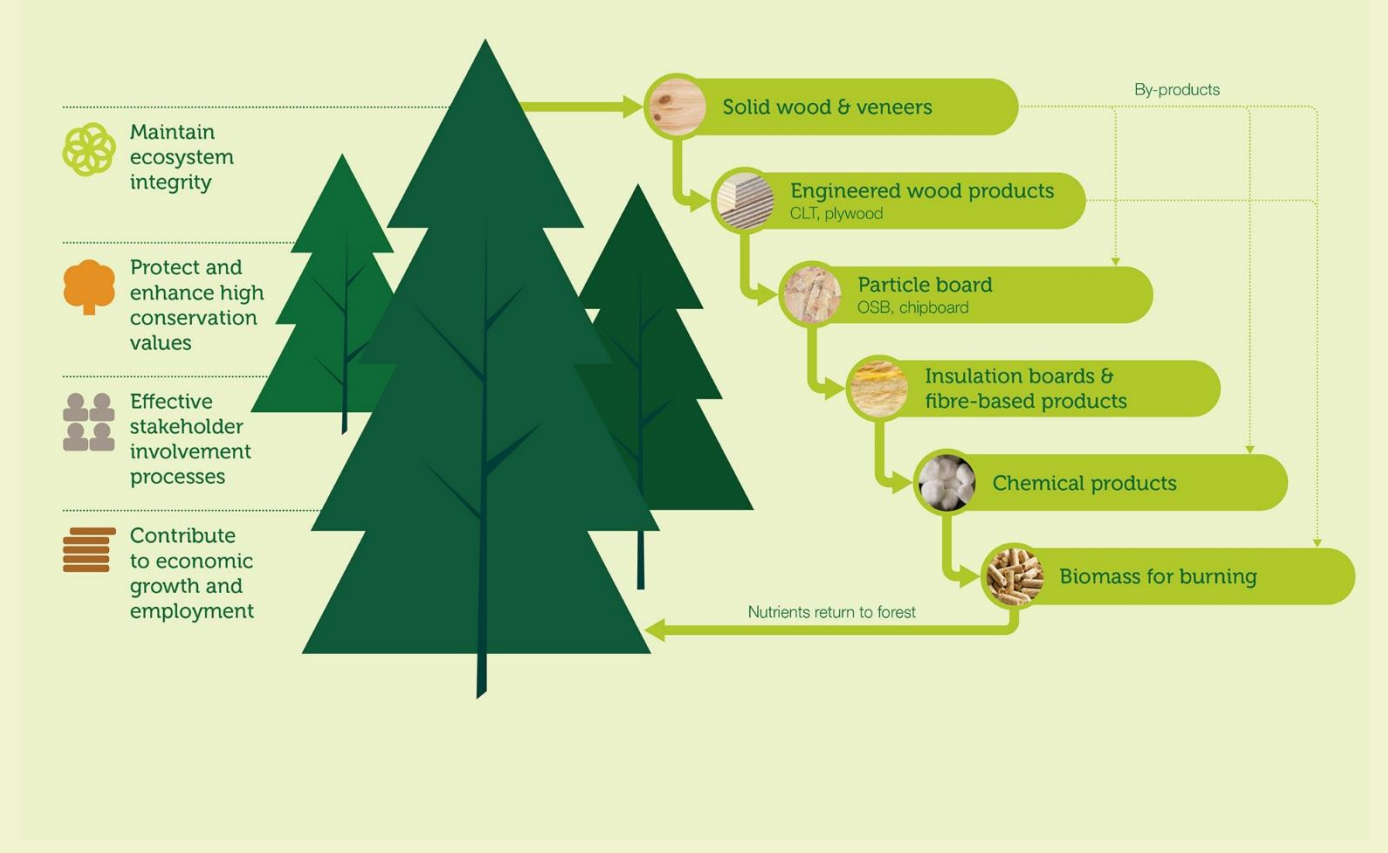
Why do we need it?

- In this illustration of cascading wood use, the re-use and recycling of wood products, combined with the reduction of waste, shows how the economic value of woody biomass can be maximised over multiple lifetimes.



Source: EFI. (2020). Why plantations must grow with the bioeconomy. https://blog.efi.int/why-plantations-must-grow-with-the-bioeconomy/

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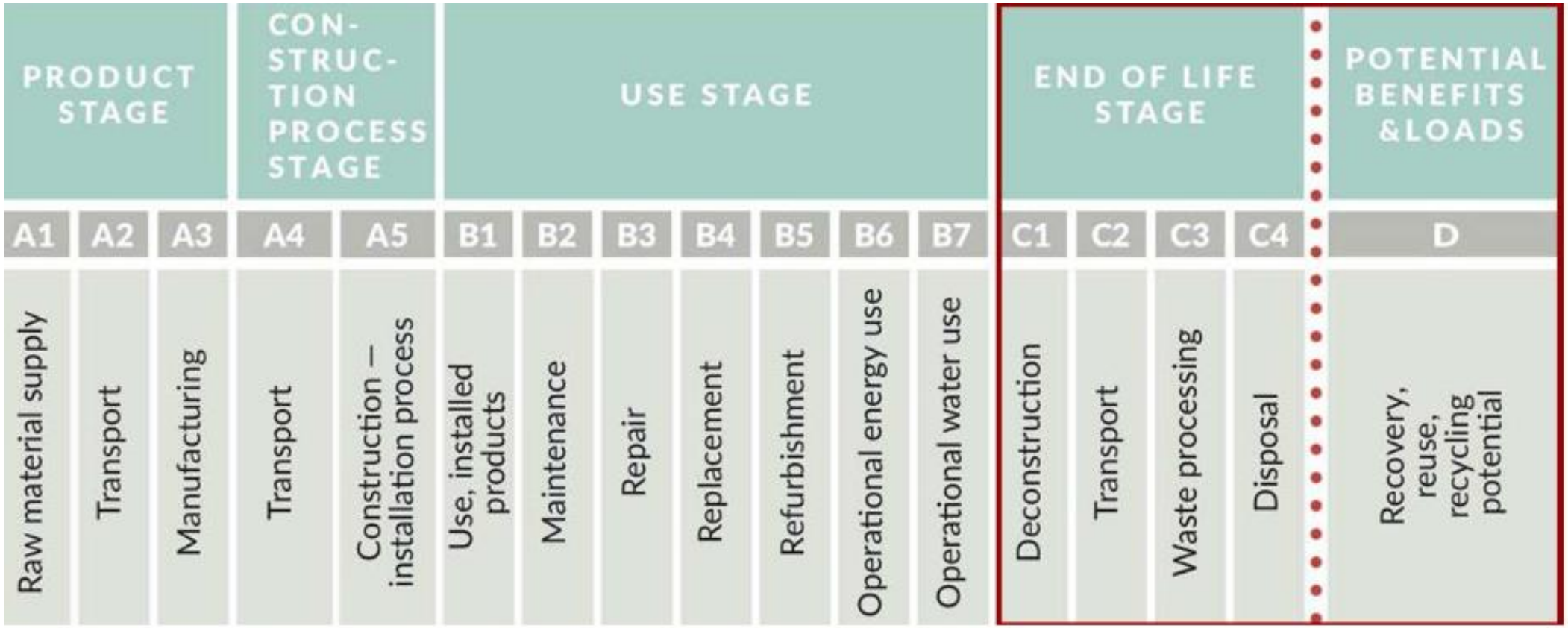
How can we use timber after demolition?

Life Cycle of a Building



Source: Stanton, A. (2021). *Reusing Mass Timber: An Investigation of the Opportunities and Challenges*. https://timbertectonics.com/2021/12/14/end-of-life-and-reusing-mass-timber/

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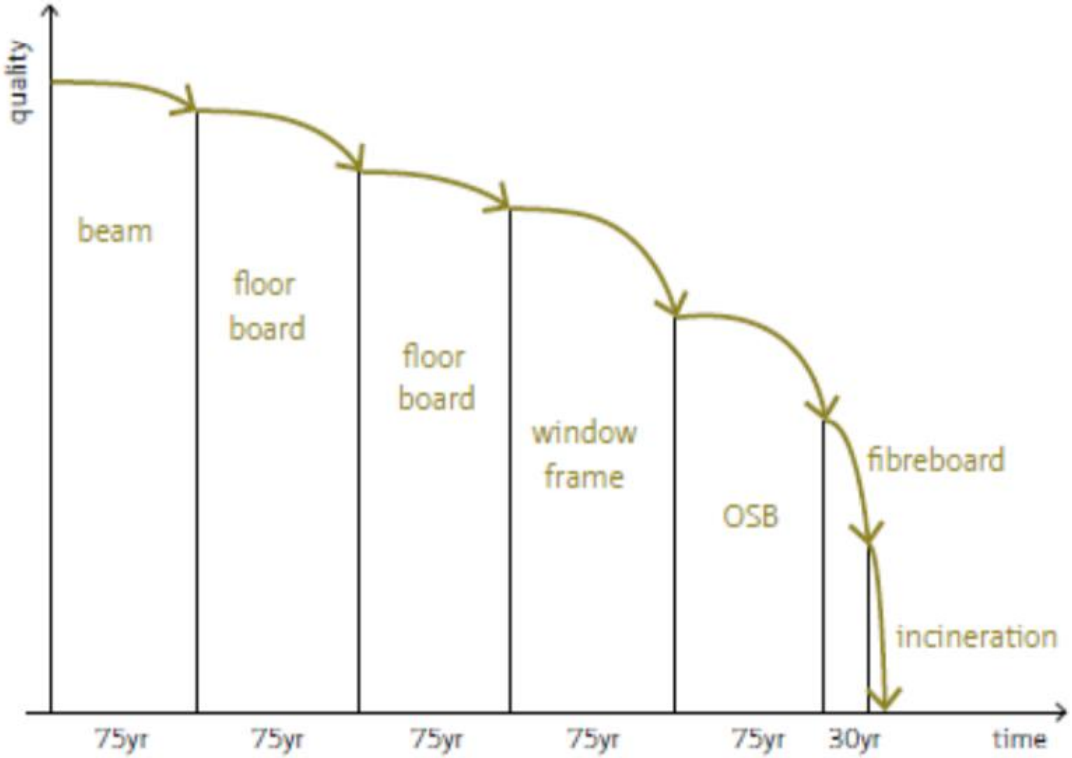
Potential cascading of pine wood



Fraanje (1998), adapted by Icibaci (2019)

Source: Cristescu, C., Honfi, D., Sandberg, K., et al. (2021). *Design for deconstruction and reuse of timber structures – state of the art review* (InFutUReWood Report:1). DOI: 10.23699/bh1w-zn97

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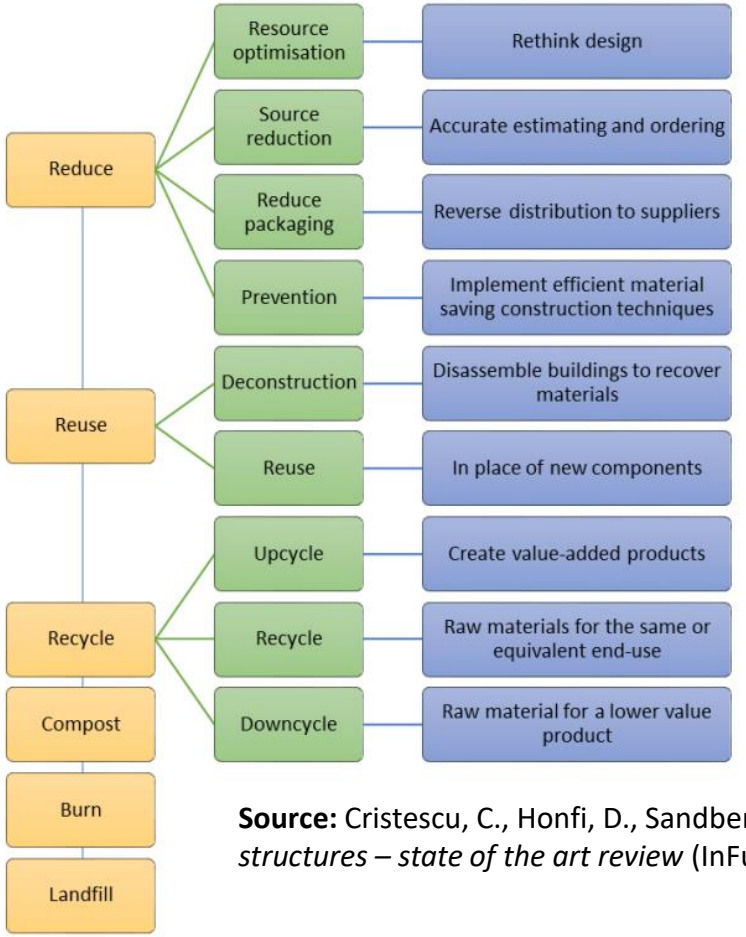
Waste management hierarchy for demolition and construction operations



Source: Cristescu, C., Honfi, D., Sandberg, K., et al. (2021). *Design for deconstruction and reuse of timber structures – state of the art review* (InFutUReWood Report:1). DOI: 10.23699/bh1w-zn97

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- “The more of a building that could be reused, the higher is the **environmental gain**, i.e. less waste will be produced, and less energy will be consumed”.

Source: https://mcgrawimages.buildingmedia.com/CE/CE_images/2018/July/July-ThinkWood-8.jpg

Source: Cristescu, C., Honfi, D., Sandberg, K., et al. (2021). *Design for deconstruction and reuse of timber structures – state of the art review* (InFutUReWood Report:1). DOI: 10.23699/bh1w-zn97

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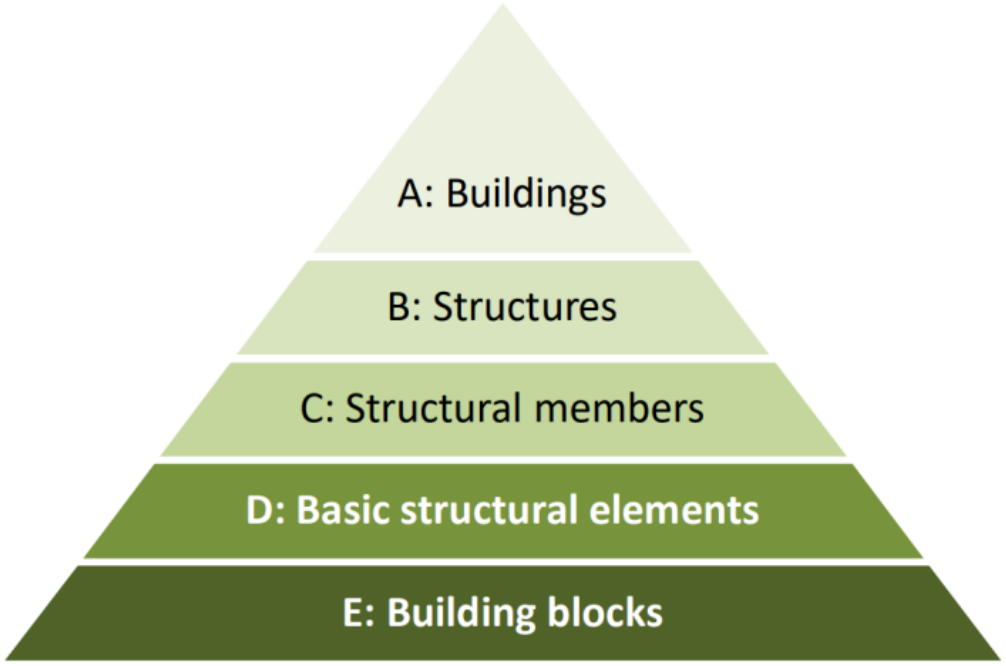
Hierarchy of building components considering reuse



Source: Cristescu, C., Honfi, D., Sandberg, K., et al. (2021). *Design for deconstruction and reuse of timber structures – state of the art review* (InFutUReWood Report:1). DOI: 10.23699/bh1w-zn97

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In the case of mass timber, reusable building components are (Hradil et al., 2014):

- A: modular houses, sports halls, bridges, towers
- B: glulam frames, roof trusses
- C: sandwich panels, curved glulam beams, ceiling joists
- D: straight solid or glulam beams, wood-based panels
- E: boards

Elements in the category …	A	B	C	D	E
… resist all structural loads and transfer them to the foundations.	x				
… have a single defined purpose.	x	x			
… have a defined size (usually including connection points).	x	x	x		
… resist some loads (excluding small loads e.g. on cladding).	x	x	x	x	
… are part of a larger system.		x	x	x	x
… can be used for more than one purpose.			x	x	x
… allow for the easy (on-site) modification of their size.				x	x
… need to be joined together to form a load-bearing part.					x

Source: Cristescu, C., Honfi, D., Sandberg, K., et al. (2021). *Design for deconstruction and reuse of timber structures – state of the art review* (InFutUReWood Report:1). DOI: 10.23699/bh1w-zn97

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Reclaimed wood

- **Reclaimed wood** is wood that has been previously logged and used for building or other projects.
- Synonyms: “recycled timber” or “reclaimed timber”.

Reclaimed Wood Table by Horgan Becket | Inhabitat |

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Which wood is recyclable and which is not?

Type of wood	Recyclable?	Compostable?
Real untreated timber	✓	✓
Woodchips	✓	✓
Plywood	✓	x
Painted wood	x	x
Fiberboard	x	x

*in this case, recyclable means cannot be brought to a wood recycling facility. Painted wood, for example, is still recyclable in the sense that it can be used for crafts.

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- Though wood can be recycled, **not all woods are capable of being recycled**. There are woods that have been chemically treated. These types of woods are not considered recyclable materials.
- Woods that have been soiled or painted are not always considered as recycling materials.
- **If you put these woods in the recycling machine, they will likely contaminate the other recyclable materials.**

Source: Conserve Energy Future. (2022). *Insights in Timber Recycling and Demolition*. https://blogs.napier.ac.uk/cwst/timber-recycling-and-demolition/

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- Mass timber has minimum end-of-life scenarios.
- In many cases the panels are disposed in the landfill due to the adhesives that are used in manufacturing the material.
- **Recycling to biofuel** and incinerating for bioenergy have come into play, however, the adhesives and chemicals create barriers for these disposal methods.
- Another option is **reprocessing and reusing the material**. Many mass timber products could have the opportunity to be dismantled from old construction, cleaned, reprocessed, and reconstructed into new structure.

Source: Stanton, A. (2021). *Reusing Mass Timber: An Investigation of the Opportunities and Challenges*. https://timbertectonics.com/2021/12/14/end-of-life-and-reusing-mass-timber/

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Secondary use solutions

Reuse or Upcycling

- Primary structural system in new construction
- Beams
- Columns

Recycling or Downcycling

- Secondary system in new construction
- Furniture
- Wood particle products

Source: Stanton, A. (2021). *Reusing Mass Timber: An Investigation of the Opportunities and Challenges*. https://timbertectonics.com/2021/12/14/end-of-life-and-reusing-mass-timber/

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Upcycling

- Upcycling is a process that proposes creative reuse with an added value of waste to a higher quality product.

https://commons.wikimedia.org/wiki/File:Palett,_upcycled_to_cofee_table.jpg

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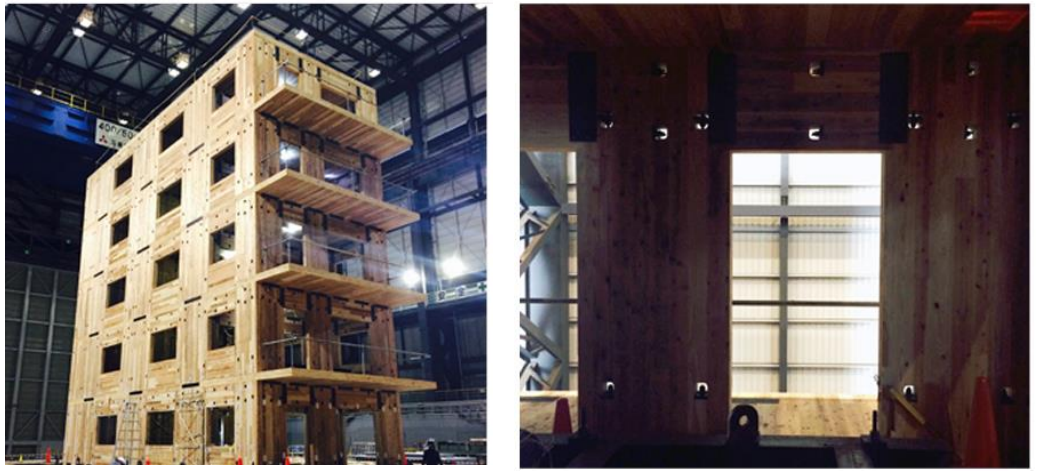
Case 1: CLT Cafe, Kobe City, Japan – Utsumi Aya Architects

- The designer of the experiment executed the connection between panels by a set of tension bolts going through each panel and fixed by nuts.
- During two days the 5-storeys specimen successfully withstand different tremor waves.
- Nevertheless, after the experiment ended, there was major damage on one corner at the ground floor.
- The structural damage decreased as a function height, and no visual damage was seen on the top floor.
- The CLT panels reused in this case study were recovered from the last storey of the 5-storeys specimen.



Sample testing

Source: Passarelli, R. N. (2018). The environmental impact of reused CLT panels: Study of a single-storey commercial building in Japan. In 2018 World Conference on Timber Engineering, Seoul, Republic of Korea.

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- The design of the CLT cafe was commissioned to Aya Utsumi, from Utsumi Aya Architects on the condition of employing the recovered panels in a cost-effective construction for a single-storey cafe building.
- Result – roof of cafe.

Photos by Satoshi Asakawa

Source: Passarelli, R. N. (2018). The environmental impact of reused CLT panels: Study of a single-storey commercial building in Japan. In 2018 World Conference on Timber Engineering, Seoul, Republic of Korea.

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Case 2: Salvage Swings Pavilion - Somewhere Studio

- The pavilion was created with reused 3-ply CLT pallets that were reprocessed and cut into smaller panels to form the box-like sections of the Salvage Swings Pavilion.

Source: Stanton, A. (2021). *Reusing Mass Timber: An Investigation of the Opportunities and Challenges*. https://timbertectonics.com/2021/12/14/end-of-life-and-reusing-mass-timber/

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Case 3: City of Melbourne CH2 Project

- Council House 2 (CH2) was built by Hansen Yuncken and was Australia's first building to be awarded a six star green star design rating.
- Approximately 20,000 lineal metres of house frame timbers were used. Approximately 270,000 old and rusty nails were removed by hand. Nullarbor Timber re-milled and re-dressed these timbers for cladding.

Source: Coulston, K. (2016). Recycled timber: material that tells a story. *Sanctuary*. https://renew.org.au/sanctuary-magazine/in-focus/recycled-timber-material-that-tells-a-story/

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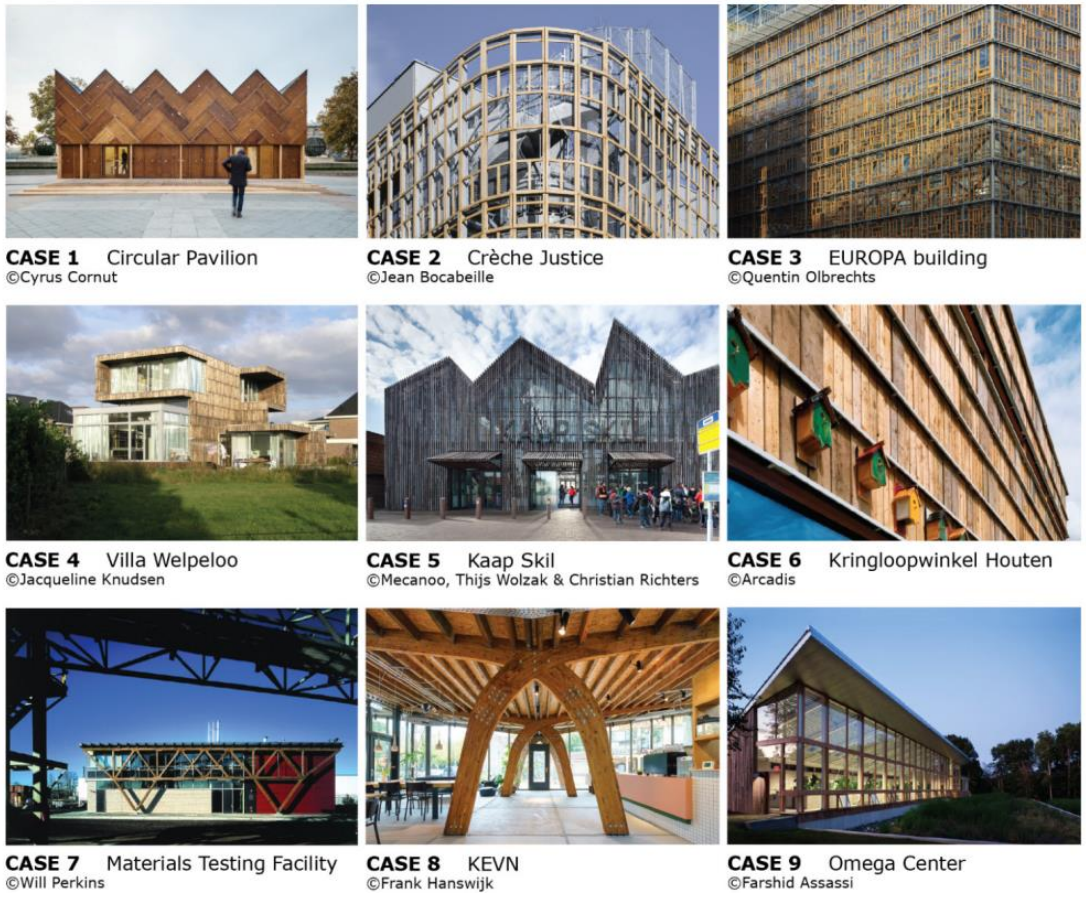
Other cases



- Cases 1 to 3 represent the reuse of reclaimed building products like doors and window frames in new façades. The EUROPA building is the only of these cases in which the reclaimed elements—in this case, window frames—were reapplied for the same function.
- Cases 4 to 6 all include façades that were clad with reclaimed materials from outside the building industry: from damaged cable reels over hardwood sheet piling to used transport pallets.
- Cases 7 to 9 finally represent the category of buildings in which reclaimed timber is used as part of the load-bearing structure.

Source: Pronk, A., Brancart, S., & Sanders, F. (2022). Reusing timber formwork in building construction: Testing, redesign, and socio-economic reflection. *Urban Planning*, *7*(2), 81-96.

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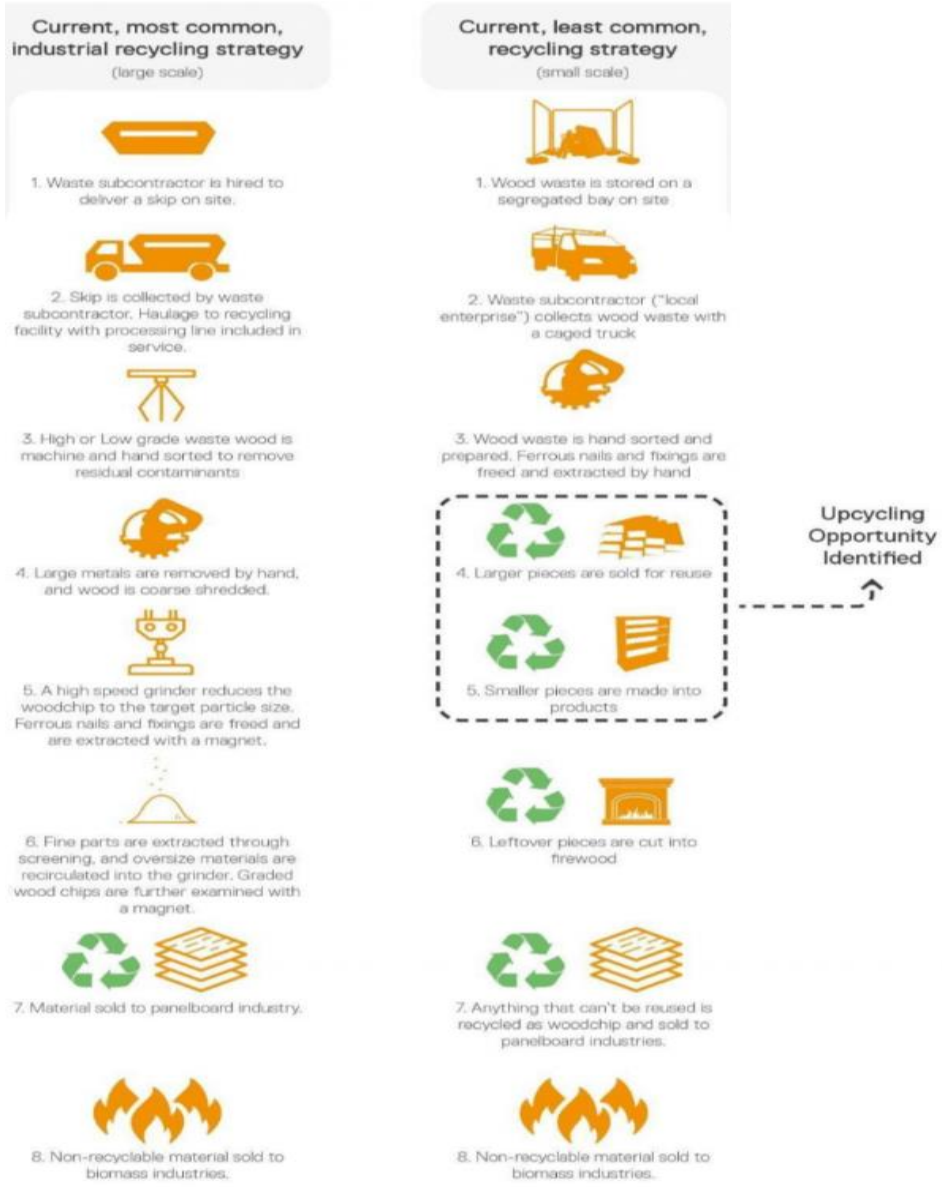

Recycling strategies

- Provided recycling strategies are based on UK's experience, indeed they are often used in other European countries.

Source: Bergsagel, D., Isaac, P., & Koeck, A. (2021). *Feasibility Study Exploring Turning Reclaimed Timber into Structural Glulam* (CIRCuIT Research Paper).

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Waste wood mix

Source: Cramer, M. (2020). Insights in Timber Recycling and Demolition. https://blogs.napier.ac.uk/cwst/timber-recycling-and-demolition/

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- Wood and timber is transported to a wood recycling facility where contaminants are removed. The wood is then broken down and manufactured into a new products.
- Even though it can be recycled, it is still a costly process to store, transport, sort and reprocess wood for other.

Source: Buckinghamshire Recycles. *Wood & timber*. https://www.recycleforbuckinghamshire.co.uk/what-happens-to-your-waste/wood-timber/

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From waste to new mass timber products

- “Used wood can easily be recycled in new mass timber products, such as CLT (cross-laminated timber) and glulam (glue-laminated timber), if it is dry and straight enough”.

Source: Built in Wood. (2022). *Used wood in new CLT?* https://www.build-in-wood.eu/post/used-wood-in-new-clt

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Practical experiment 1: Turning reclaimed timber into structural glulam

- Timber from a demolition site in South London was supplied by Keltbray. The team characterised the timber to assess damage sustained during it's in service life and removal that may impact the structural properties. Following this, longitudinal acoustic resonance tests were conducted to provide an estimate of the elastic modulus.
- Upon completion of the characterisation process the timber was transferred to Buckland Timber, the UK's only manufacturer of glue laminated timber.
- Buckland carried out their own additional assessment before creating 6 glue laminated beams from the waste timber which will be mechanically tested at Napier University, Edinburgh.

Source: Bergsagel, D., Isaac, P., & Koeck, A. (2021). *Feasibility Study Exploring Turning Reclaimed Timber into Structural Glulam* (CIRCuIT Research Paper).

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From waste to glulam

Source: Bergsagel, D., Isaac, P., & Koeck, A. (2021). *Feasibility Study Exploring Turning Reclaimed Timber into Structural Glulam* (CIRCuIT Research Paper).

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Practical experiment 2: Reused wood in new CLT slabs

- Norwegian waste management company Ragn Sells provided Norwegian Institute of Wood Technology (NTI) with discarded slats, that were then cleaned and planed. The old slats were glued up into a five-layered-CLT prototype.
- NTI conducted the following tests with very positive results:
  - Stiffness and flexural strength: No weakness detected in the tests
  - Adhesive tests: The adhesiveness is not weakened
  - Demolition damage: hardly affects the properties of the returned wood (most of the wood has been through demolition processes)
  - Shear properties: satisfactory results (tested in prototypes with short spans)

Source: Built in Wood. (2022). *Used wood in new CLT?* https://www.build-in-wood.eu/post/used-wood-in-new-clt

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Production of CLT slabs

Source: Built in Wood. (2022). *Used wood in new CLT?* https://www.build-in-wood.eu/post/used-wood-in-new-clt

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