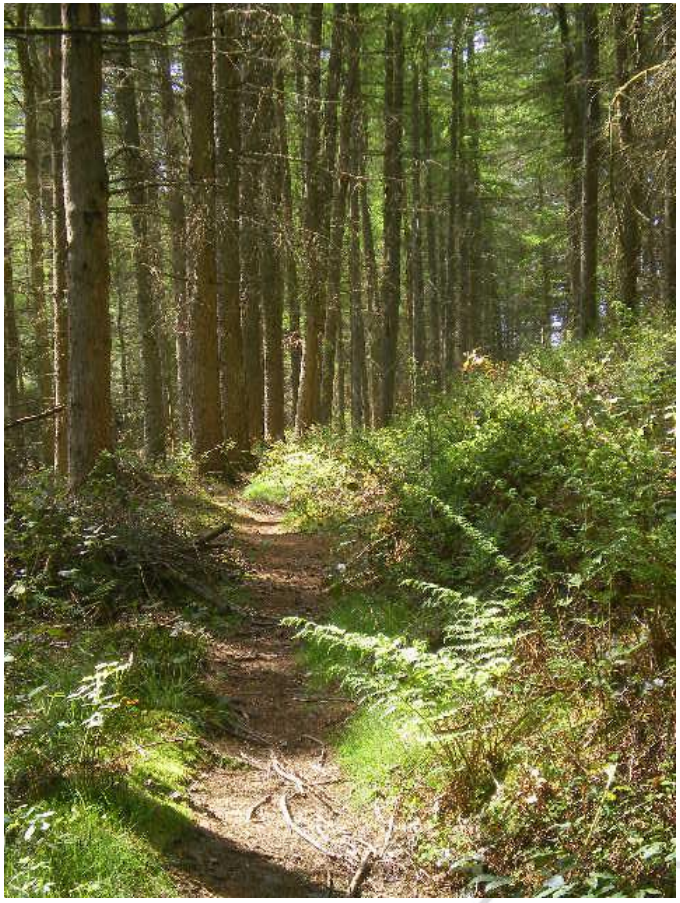
Biogenic carbon

Its joint roles in bioenergy and carbon sequestration

Presentation to 12th ECCRIA Conference

6th September 2018

What lovely biofuel?



Introduction

- Demand for timber is set to increase
- Sustainable production and renewable material
- Excellent carbon profile
  - i.e. low embodied carbon
  - and high sequestered carbon content
- Also, demand for renewable biomass for energy
- And demand for renewable and recyclable materials in a circular economy

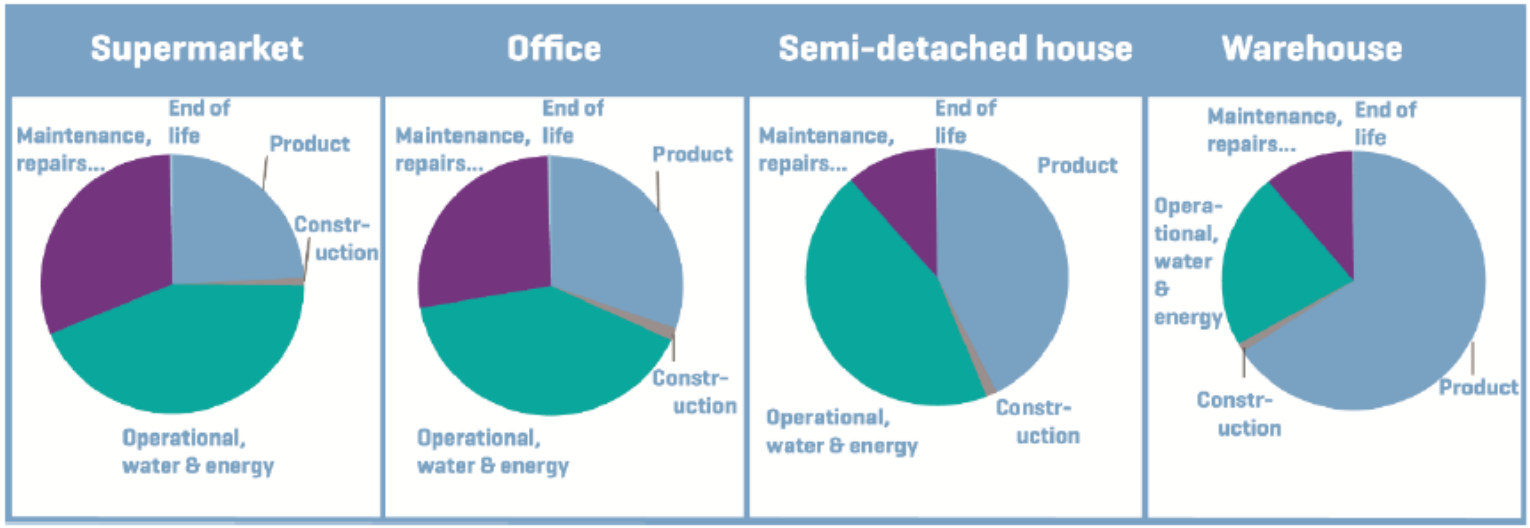
National carbon budgets

Budget	Carbon budget level	Reduction below 1990 levels
1st carbon budget (2008-12)	3018 MtCO2e	25%
2nd carbon budget (2013-17)	2782 MtCO2e	31%
3rd carbon budget (2018-22)	2544 MtCO2e	37% by 2020
4th carbon budget (2023-27)	1950 MtCO2e	51% by 2025
5th carbon budget (2028-32)	1725 MtCO2e	57% by 2030

Looking beyond energy efficiency measures

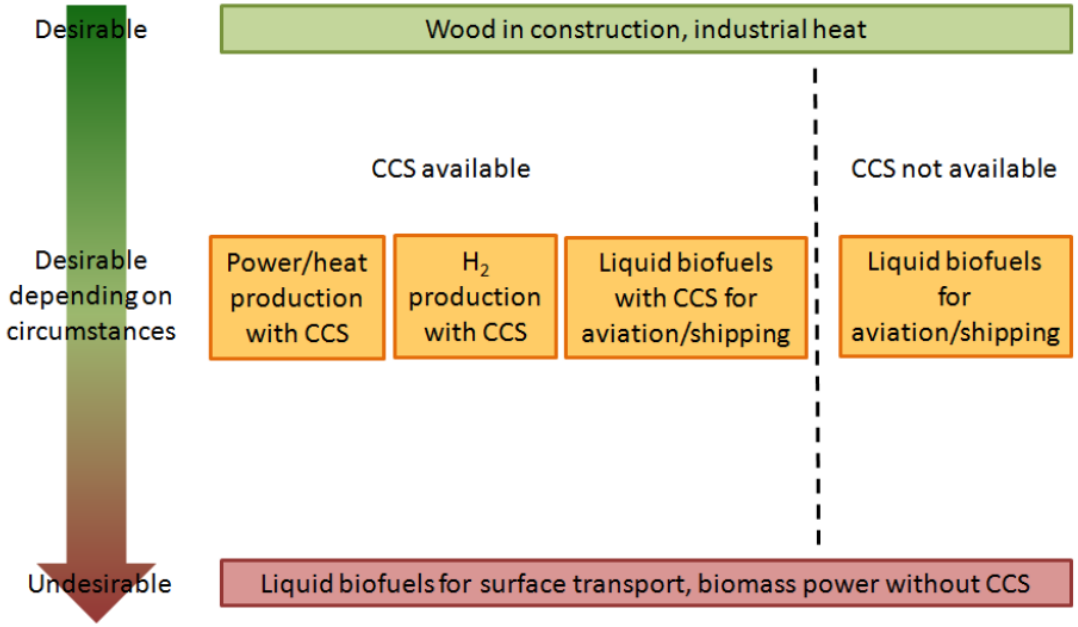
- As buildings become more energy efficient the importance of the energy and carbon associated with construction materials will become more prominent
- Increased importance in designing efficiently with the materials resource
- Increased consideration of global warming potential (GWP) of buildings at build stage
- Also the potential to store sequestered carbon in materials such as wood

Example data



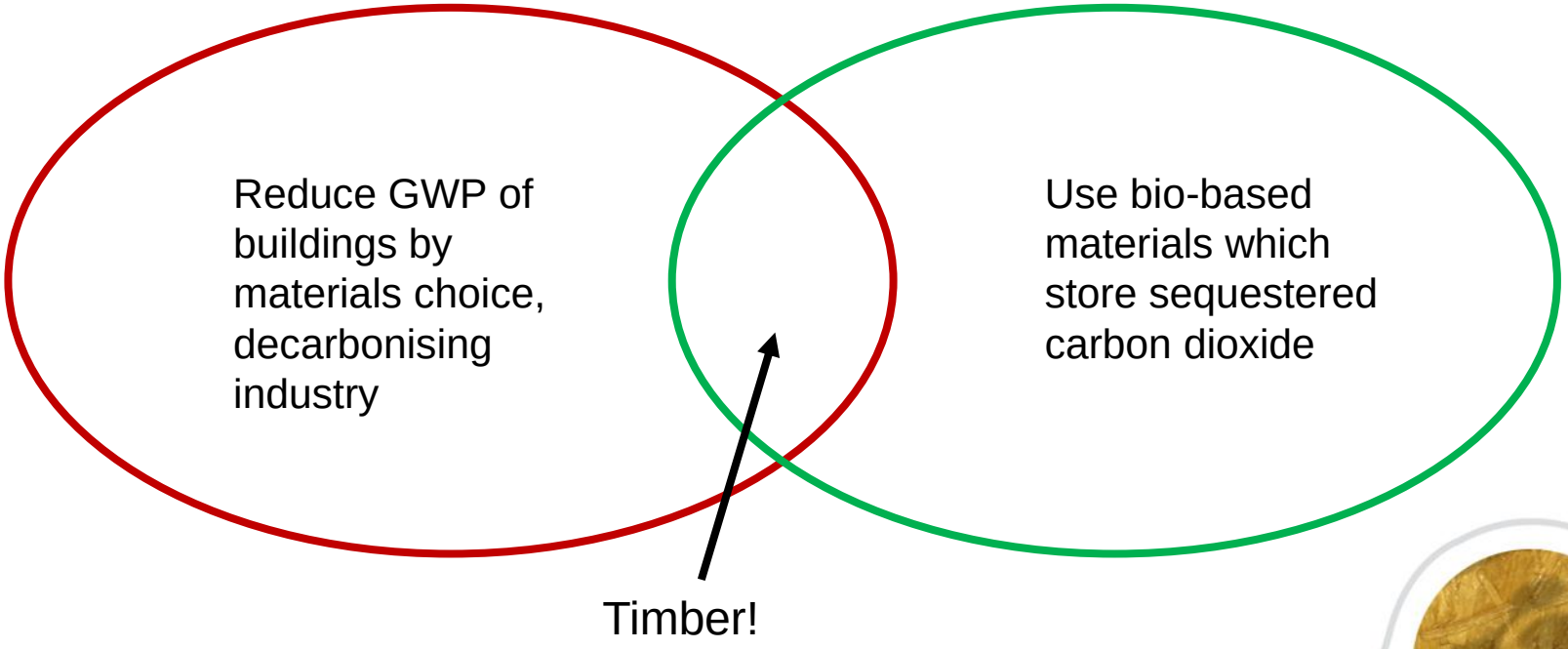
Example breakdown of embodied vs operational carbon by building typology (RICS Professional Guidance, 1st Edn, 2014)

Hierarchy of appropriate use



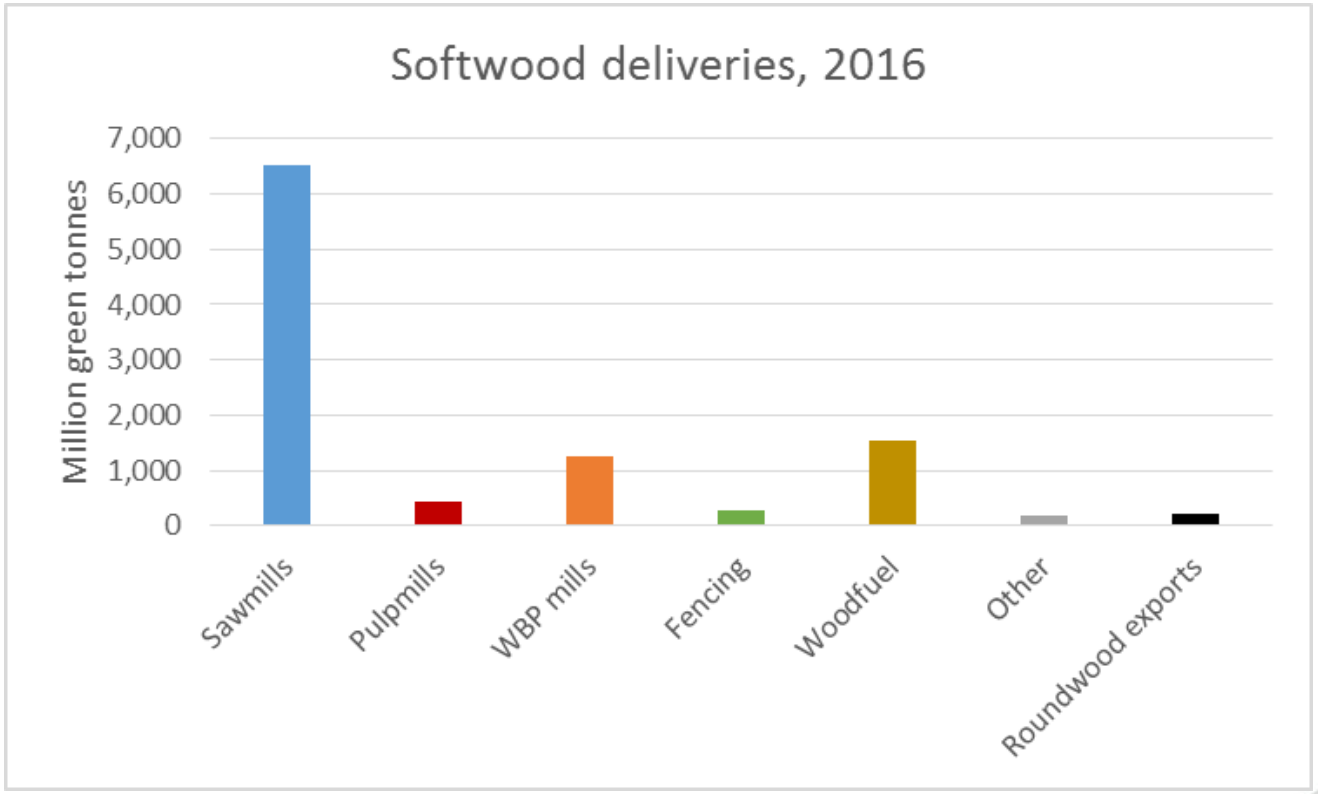
(Source: CCC Bioenergy Review, 2011)

Two options



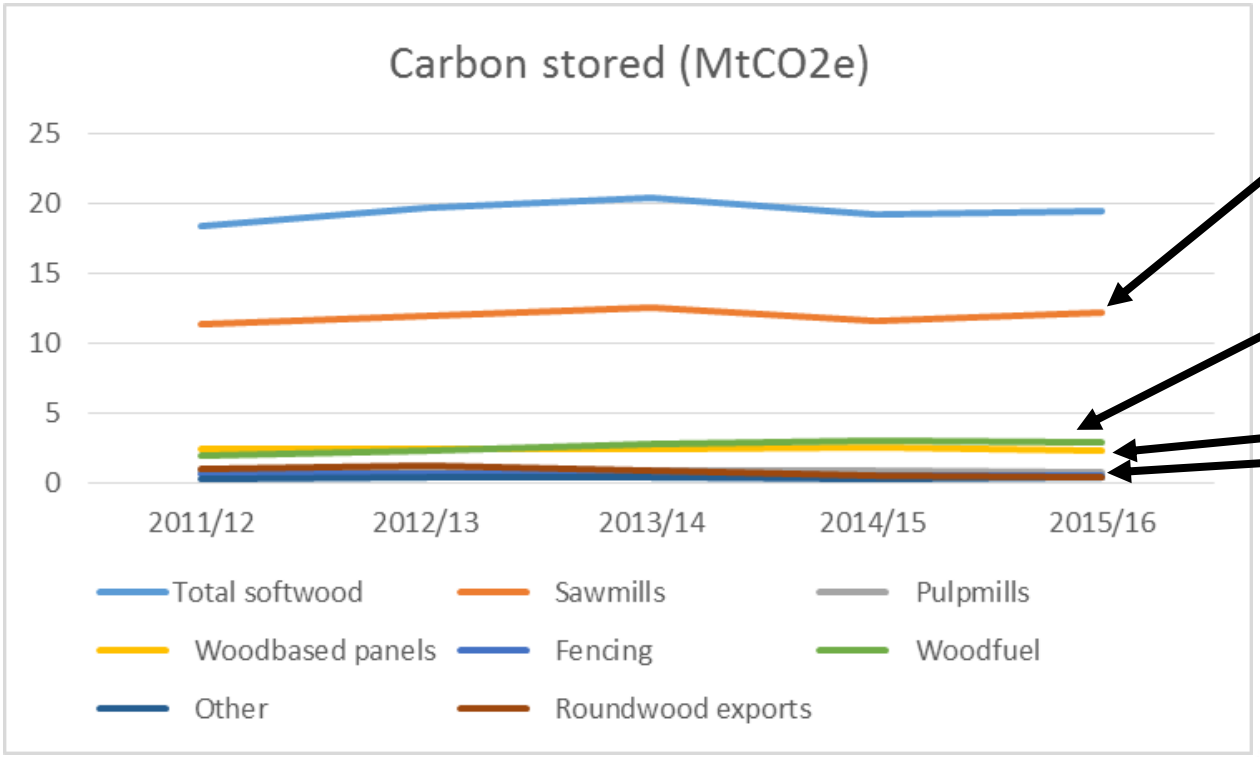
But – don't we need all that wood for bioenergy?

Available resource



10.4 million tonnes UK grown softwood, 2016

Softwood forest output – as sequestered carbon



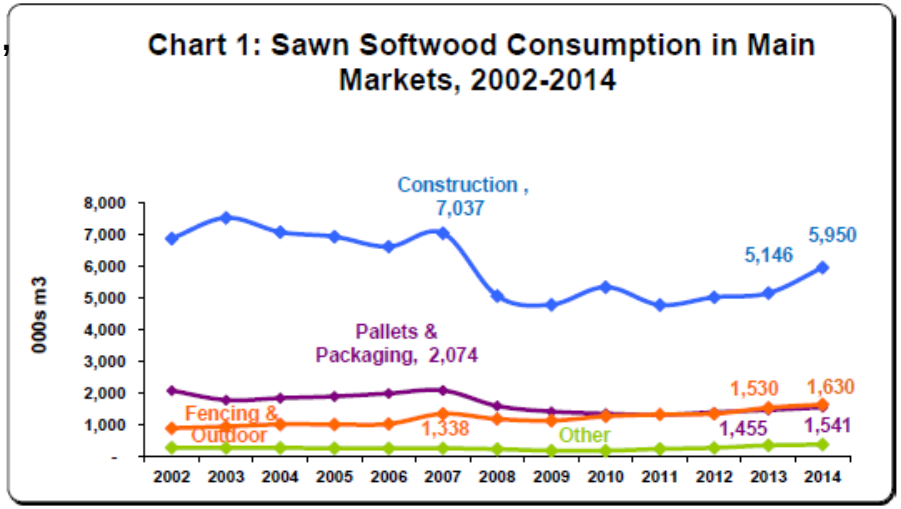
Stored in buildings

Re-released to atmosphere

Short to medium term storage

Available resource

- Current use of wood in construction
  - Near 6 million cubic metres of sawn softwood timber
  - 62.7% of timber consumption in UK, 2014 data
  - UK producers supply 37.5% of sawn softwood (2014)
  - But UK forests only supply 16% of construction timber (2014)
  - Imports make up the rest of this, 973 vs 4977 thousand m^3 respectively



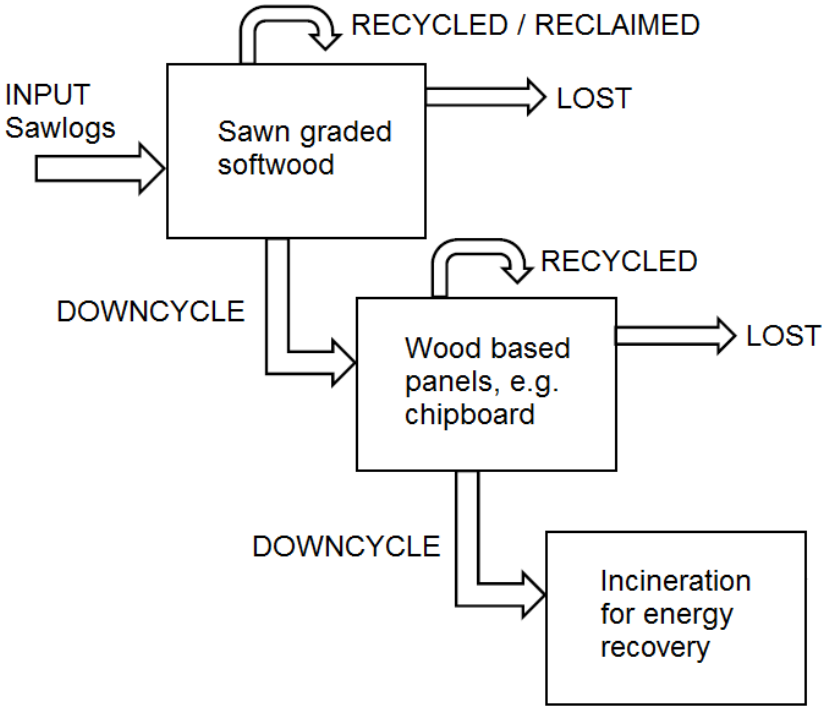
Conversion

- For each log which is converted, there is a volume of slab wood and sawdust and planer shavings generated
  - E.g. 5 million m^3 sawn wood, may have been produced from circa 10 million m^3 of roundwood
- This may be used on site to heat wood drying kilns, or sold as co-products to secondary production
  - e.g. wood based panels (MDF, chipboard),
  - or animal bedding,
  - or horticulture,
  - or bioenergy pellet manufacture

Cascading

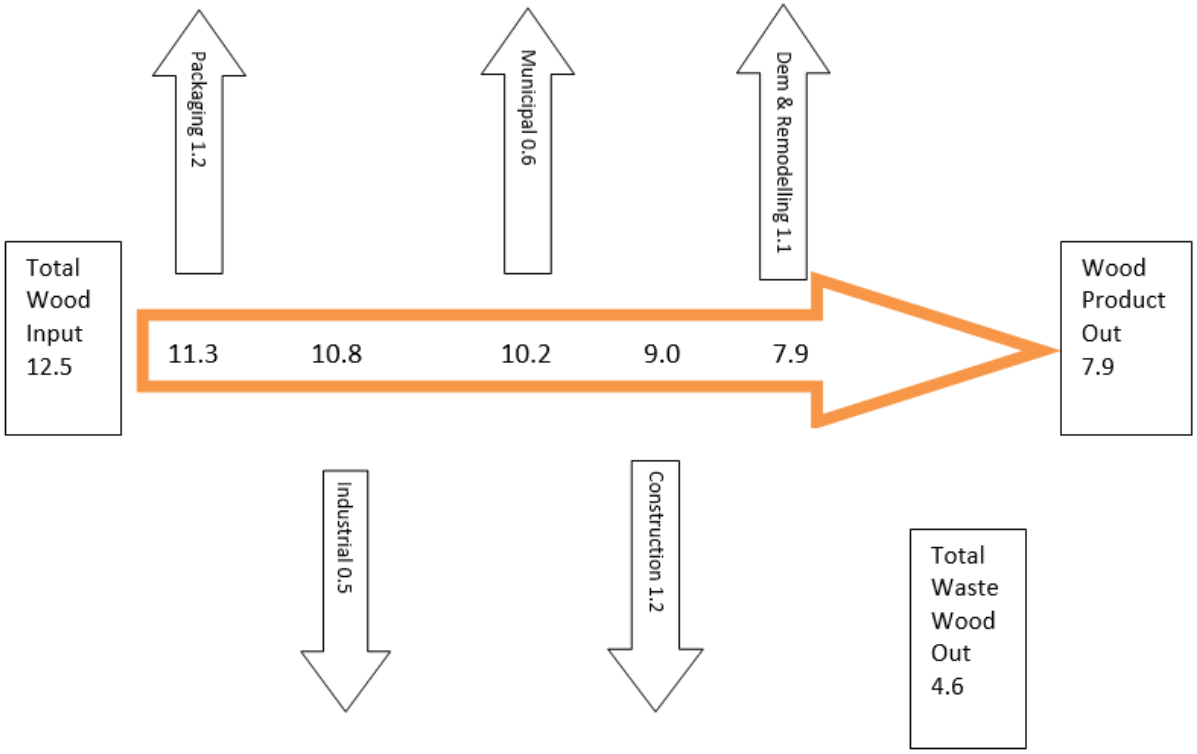
- There is also a well established wood recycling system
- Residues from industrial processes (e.g. furniture factories, joinery manufacture) or collected on construction sites can be sold to wood based panels, animal bedding, bioenergy etc.
- Recycled wood – post consumer (e.g. used furniture, fitted kitchens) or demolition waste (e.g. beams, wood based panels, small dimension wood)
  - e.g. into reclaimed timber market,
  - or wood based panels manufacture,
  - or bioenergy, etc.
- Cascading describes the sequence of uses moving from high value initial product, to secondary use, with repeated recycling until ultimate energy recovery

Cascading



Note there are many, many other routes through the forest products chain

How much recycled or cascaded wood is there?



Flow of main waste types from wood product mix (data from WRAP report 2009).

UK biomass – waste wood

Total wood waste WRAP 2009	4572.9 thousand tonnes	
Packaging	1169.9	Suitable
Industrial	462.5	Suitable
Construction	1184.5	May be suitable
Demolition	1137.4	May be suitable
Municipal	618.7	May be suitable

In 2008, waste wood for bioenergy was 200 kt
Which has increased to 1.5 Mt (2016, WRA)
Expected to double in 2017-18, i.e. 3 Mt approx.
Total waste wood generated in UK 5 Mt (2017, WRA)

What is embodied carbon?

- The embodied carbon is the CO_2 burden associated with the production processes
- For wood this could include:
  - forest activities (harvesting activity, fertilizer application, thinning etc);
  - extraction and transport;
  - sawmilling activities;
  - kilning; etc
- Report global warming potential as tonnes of CO_2e, as it includes not only CO_2, but also other Kyoto gases such as methane

ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Mineral Products Association (MPA) UK
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-MPA-20170159-CAG1-EN
Issue date	14/11/2017
Valid to	13/11/2022

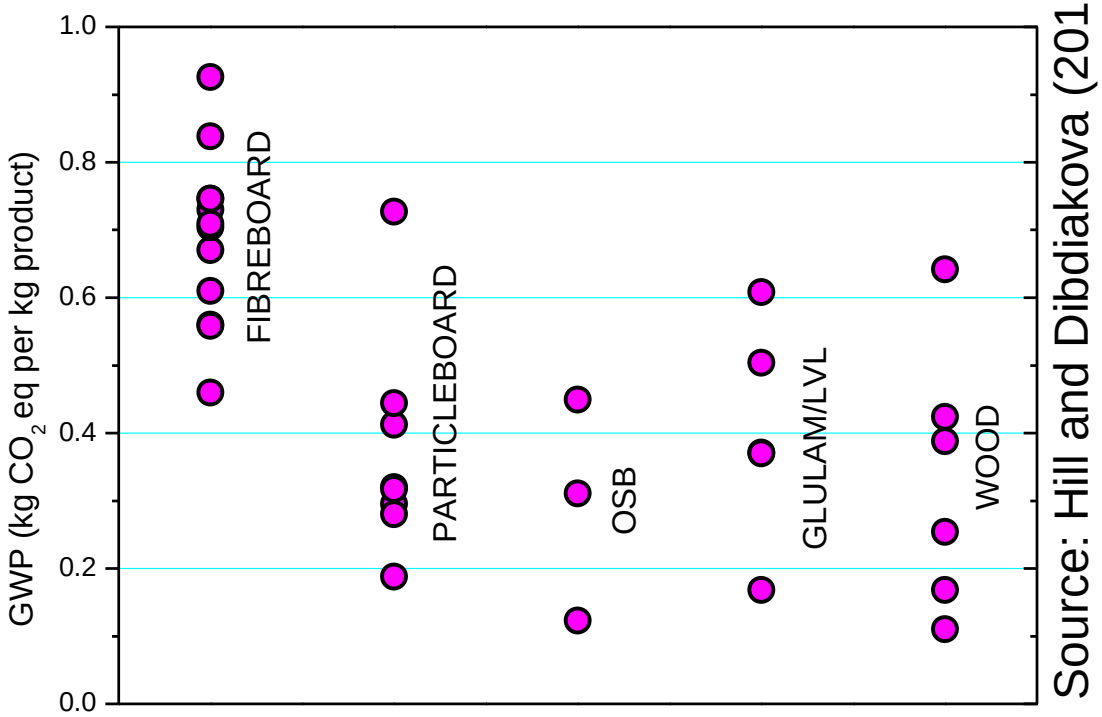
UK Average Portland Cement

Mineral Products Association (MPA) UK

www.ibu-epd.com / https://epd-online.com

Institut Bauen und Umwelt e.V.

Survey of EPD data – wood products



Source: Hill and Dibdiakova (2016) *Int. Wood Prod. J.* **7**:215

LCA and functional units

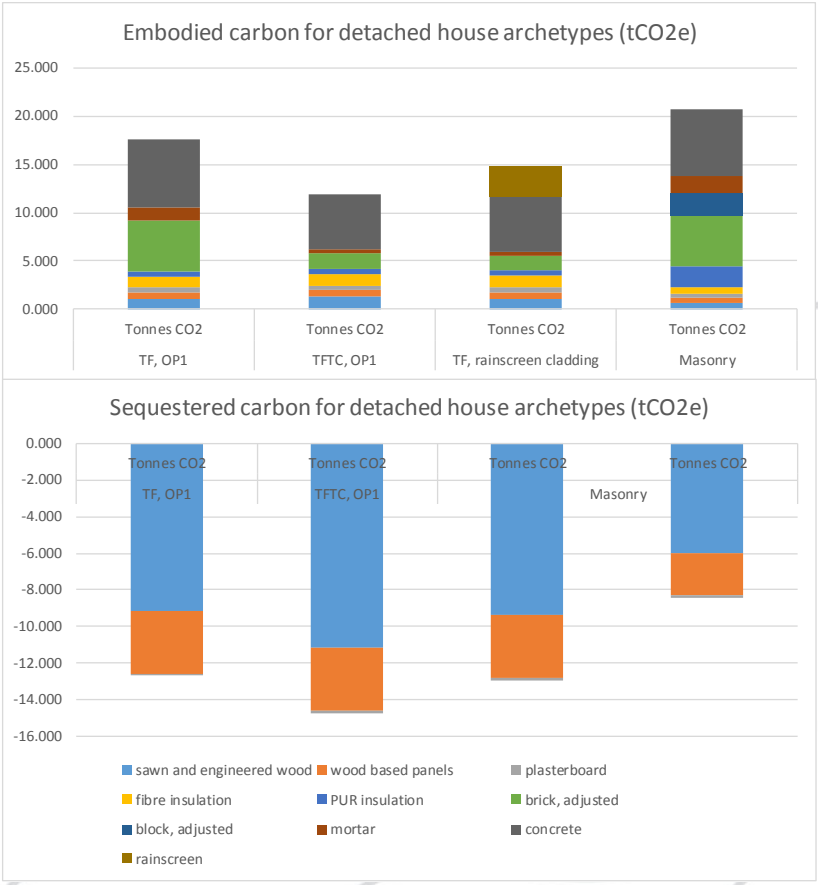
- Life cycle assessment considers GWP as one of several metrics for environmental profile of a product
- Essential for any comparisons that you define a functional unit, i.e. a quantity of product that delivers a quantity of service
- Ensures product equivalence when comparing dissimilar materials which provide equivalent functions
- An example could be a paving slab vs tarmac vs timber decking
- All provide a walkable surface for pedestrians, consider a specific area, and possibly a specific duration of service

Applying LCA to house archetypes

- Project has considered buildings using open panel timber frame, and compared with traditional brick and block masonry
- Very different components, but both support the roof, define the living space, and provide shelter
- Functional unit = single dwelling
- Can then consider all elements, including insulation to meet Part L of building regulations
- Same floor plan and no of bedrooms, i.e. product equivalence in delivery

Calculating GWP of buildings

- Comparisons based on dwellings of matched floorplan
- Embodied carbon
- Sequestered carbon
- Detached house example
  - Timber frame
  - Timber frame with timber cladding
  - Timber frame with a fibre cement rainscreen cladding
  - Brick and block



Thought experiment: A model town

- If we assume a blank canvas:
- Houses e.g. 5000
- Flats (mid-rise) e.g. 750
- Shops: Shopping arcade including entertainment venues
  Local ‘corner’ stores
  Out of town retail units
- Office space e.g. 100 units
- Industrial space e.g. 30 units
- Civic and religious buildings
- Sports centre
- Schools, further education
- Integrated health centre

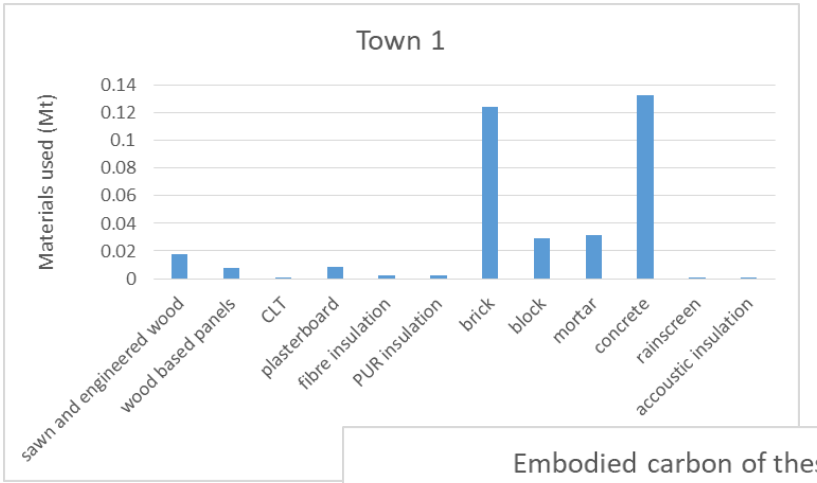
Model town housing

Housing mix:	Model town
• Flats / apartments	13%
• Bungalows	5%
• Detached	30%
• Semi-detached	25%
• Terraced	27%

- Consider timber framed and masonry construction
- Also cross-laminated timber and concrete framed system in the flats and apartments

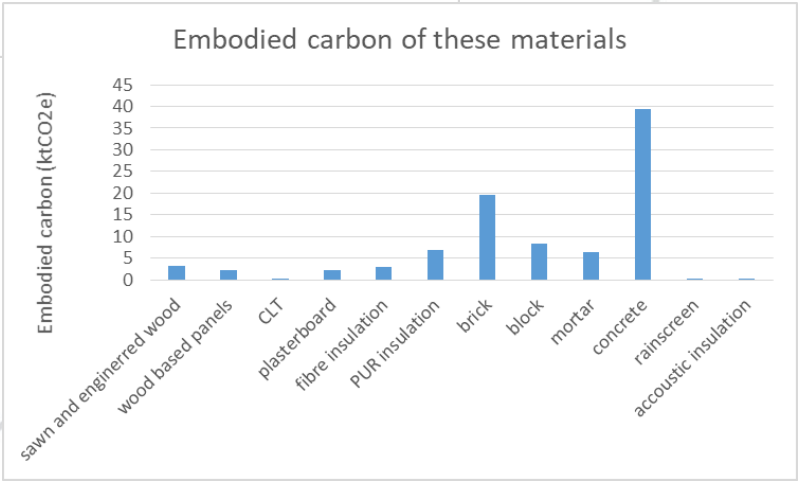
Just considering the housing mix

- Materials usage



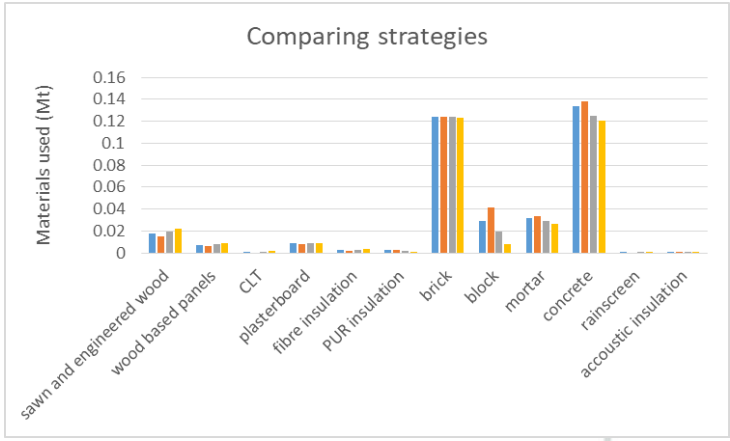
- And associated GWP

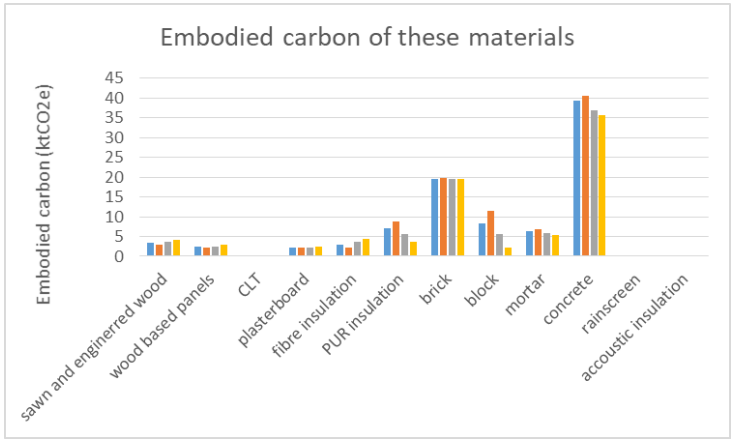
- Note that some materials have higher GWP per tonne than others

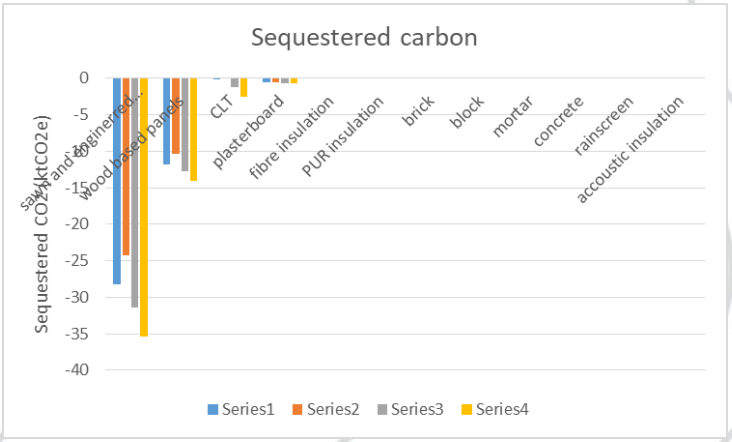


What about different build methods?

- Comparing current (28% TF) with
- No timber frame
- Double timber frame plus CLT (10% of flats)
- High timber frame plus CLT (20% of flats)







Total effect of building new town in different materials

	Embodied CO_2 $ktCO_2e$	%	Sequestered CO_2 $ktCO_2e$	%
Normal mix	91.56		-40.71	
No TF	96.87	+ 5.2	-35.25	-13.4
High TF	85.87	-5.1	-46.06	+13.1
Max TF and CLT	80.36	-10.5	-52.54	+29.1

- Increasing timber frame and mass timber usage leads to decrease in embodied carbon
- And significant increase in stored sequestered carbon

Non-residential buildings

- Wide variety of structures, forms, and design solutions
- Use of mass timber building systems can both reduce GWP and increase sequestered CO_2
- Consider on a case by case basis – meeting the performance of the design to the requirements of client
- But calculating GWP using EPD data embedded in BIM modelling systems

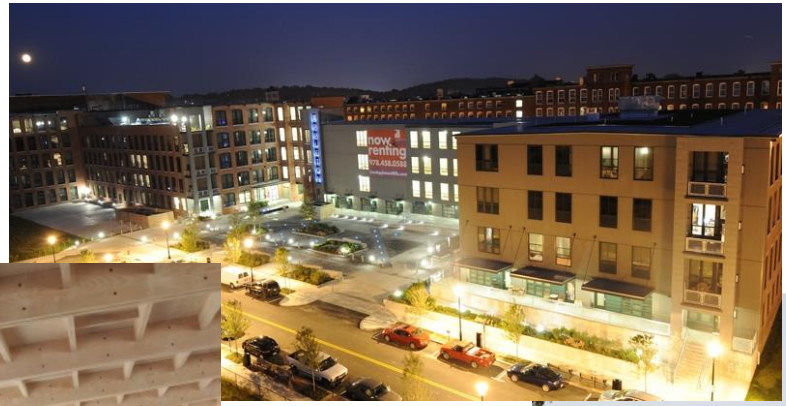
Retail complexes

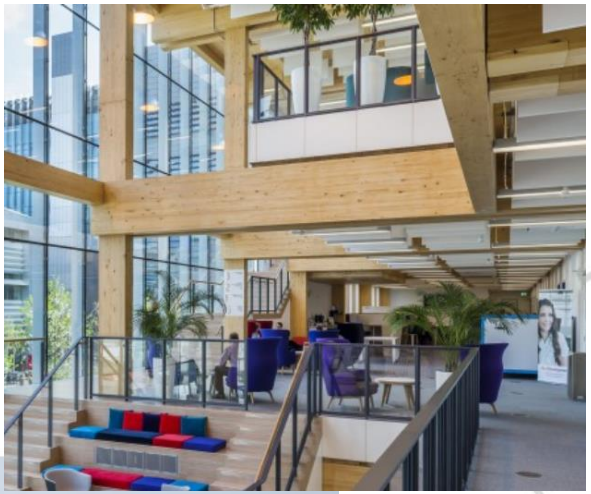
- Timber has been demonstrating suitability here for many years
- e.g. Sheffield Winter Garden, glulam parabolic arches
- Modern examples using glulam gridshells
  e.g. M&S Cheshire Oaks

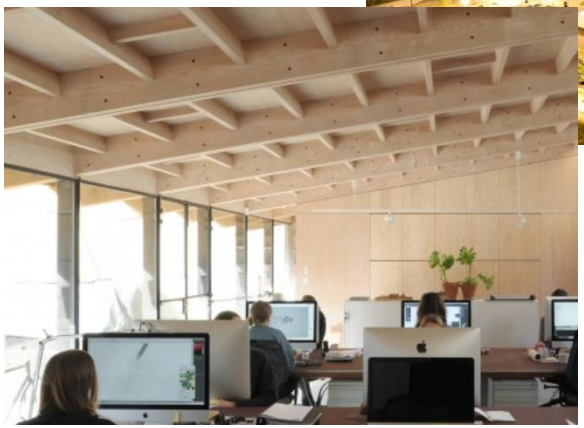
Out of town retail

Office space

- Many options for medium rise and low rise
- Open plan and small units

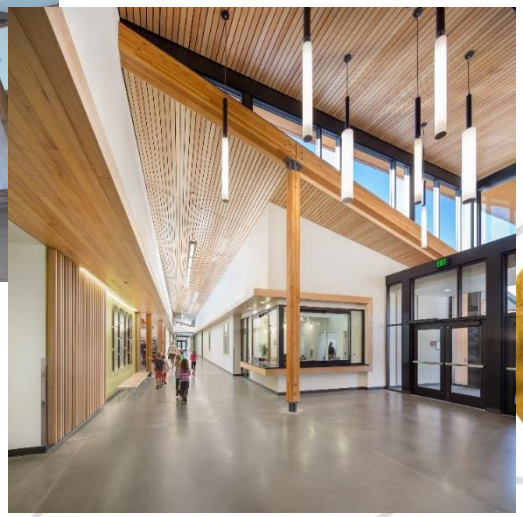


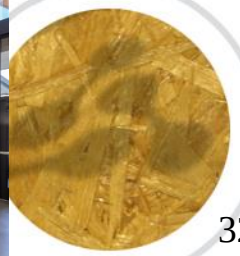




Schools

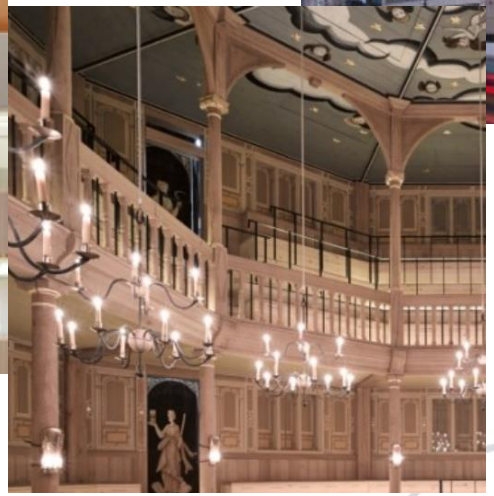
Well suited to glulam and LVL, or CLT





Public spaces

- Concert halls
- Libraries
- Churches



Sports centre, swimming pool

- Steel frame? Glulam frame?
- Long track record of delivery in this sector
- Not just swimming pools… club houses, football stands

An eco-town?

Very possible!

Model town: Timber required

- The housing component requires:
  - 17.6 kt sawn wood
  - 7.4 kt wood based panels
  - 0.2 kt CLT
- The non-residential buildings,
  e.g. a primary school 0.3 thousand tonnes CLT,
  and a supermarket e.g. 0.05 kt glulam,
  and a small complex of 6 shops including newsagent, hair salon, etc
  e.g. 0.05 kt timber,
  and two office developments with 10 units each
  e.g. 0.2 kt CLT
- Total: 25.8 kt wood, engineered wood and wood based panels
- Equivalent to 51.6 thousand m^3 solid wood
- Equivalent to 41.2 ktCO_2e stored sequestered carbon

Summing up

- Expect increased interest in the embodied carbon of materials in the built environment, to assist attainment of GHG abatement targets
- Using a model town example, the data highlighted these two benefits of a move to increased wood in construction:
  - Decreased total building GWP (up to 10% reduction for houses)
  - Increased building sequestered carbon dioxide (up to 29% increase)

Summing up

- Timber from UK forests and from imports are required for this
- UK supply is set to increase to 2027 as forest matures
- Sawing timber for structural and related uses generates significant co-product quantities, supplying industry and bioenergy
- Cascading of wood at end of life will become increasingly efficient, suppling a significant bio-energy resource
- A healthy forest products sector can be combined with a growing use of timber in construction
- This has a knock on benefit to the bio-energy sector, ensuring supply

Acknowledgements

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Thank-you for your attention!

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