USING WOOD WELL

APPLYING THE USING WOOD WELL METRICS TO YOUR BUILDING:

A WORKED EXAMPLE OF CHARLTON WORKSTACK

CHANGE BUILDING

ICD University of Stuttgart

WAUGH THISTLETON ARCHITECTS

Funded by BUILT BY NATURE

MAIN AUTHORS

Adrian Campbell (Change Building), ORCID 0000-0002-9384-0484
Hana Svatoš-Ražnjević (ICD Institute for Computational Design and Construction at the University of Stuttgart), ORCID 0000-0002-4622-5403
Alastair Ogle (Waugh Thistleton Architects)

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Supporting authors: Hans-Jakob Wagner and Achim Menges (ICD) Harry Mortimer and Kirsten Haggart (Waugh Thistleton Architects)
Contributors: Arup, CONFOR, Elliot Wood, Evolving Forests, Soren Jensen Engineering and The Royal Society of Forestry.
Peer reviewer: Dr Morwenna Spear of the Biocomposites Centre at Bangor University.

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FRAME - WUI AND URR WORKED EXAMPLE

Level 2 (Frame) Analysis

WorkStack, Charlton, dRMM

INTRODUCTION

This project has been focused on refining how to best calculate and use the metrics Wood Use Intensity (WUI: volume of timber / area), Bio content (BIO: volume percentage of bio based material) and Use to Renewal Ratio (URR: Expected use life of element / growth rate of material).

After trailing the different and evolving methodologies we decided on splitting the metrics into three different 'levels' of metrics not one single value which work with different levels of input data. This allows:

- the use of available data
- useful metric during the design phase that is easy and actionable
- different levels suited for different stakeholders or design stages to cover all three levels
- Links URR to the building scale in Level 2 and 3
- Allows for a full building study to align with an WLC assessment and floor areas in Level 3.

LEVEL 1 – GENERAL

This uses General project data, total timber volumes and floor areas. Its primary use is for benchmarking and allows for the inclusion of the largest amount of available data.
Output: $WUI_{general}$

LEVEL 2 – FRAME

This metric can also be used to improve the material efficiency of the structure. It is quick to calculate during the design phases to optimise the amount of timber in the structure which is typically a large amount of the upfront carbon and more likely to be Bio based.
Input: Detailed Superstructure information
Output: WUI_{floor}/ WUI_{frame} /URR_{frame}/BIO / Volume and Non-bio Volume

LEVEL 3 – BUILDING

This can be read and conducted alongside a WLC assessment to review all the timber used in the project. Gathering the additional data required will take time which will be best conducted when a WLC calculation process is already being undertaken.
Input: Detailed building information of all elements
Output: WUI_{build}/URR_{build}/ Bio Volume/Non-bio Volume
Definition and data on all superstructure, façade, finishing elements

This document shows a worked example for calculating Level 2 – Frame.
This case study provides an example of how to calculate Level 2 – Frame WUI and URR by hand. An automated tool is being developed that does this calculation with data extracted from a BIM model.

Data may also be obtained from detailed LCA either of the structure (say using IStructE tool) or from a proprietary detailed tool.

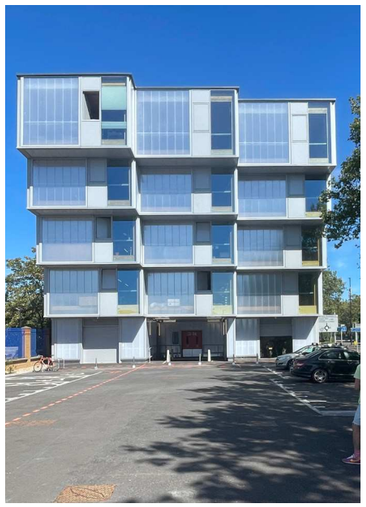
FRAME - WUI AND URR WORKED EXAMPLE

Level 2 (Frame) Analysis

WorkStack, Charlton, dRMM

PROJECT EXAMPLE:

Charlton WorkStack, a 5 storey light industrial building in London built using CLT and lower braced steelwork podium.



Photograph of WorkStack

© dRMM/Alex de Rijke

PROCESS SUMMARY:

1. Measure the Gross Structural Slab Area (GSSA) which is the area of the structural slab and structural superstructure at each level.
2. Classify the full primary structure by location and material,
3. Measure each structural elements by volume and mass.
4. Assign Use Renewal Rate to each Bio Based element.
5. Calculate Bio Mass and Volume
6. Calculate URR Range
7. Calculate Wood Use Intensity

THE METRICS

Using this guide to measure your building to the Using Wood Well metrics you will calculate the following:

WUI - This is a measure of the efficiency of wooden construction products in buildings.
Formula: **volume of wood (m3) in products / building area (m2)**

BIO - This is an measure of the significance of biomaterials used in the building relative to other non bio-based materials within the same scope.
Formula: **(wood-based material by volume (m3) / all material by volume (m3) x 100)**

URR - This is a measure of the sufficiency and long term sustainable supply of resources and using materials for longer than they take to grow.
Formula: **time in use (years) of a product / harvest time (years) of the source material**
The metric provides a lower (minimum market) and upper (average actual) range of how long materials last in a building.

1. AREA MEASURE

Using data from the BIM model, the Gross Superstructure Slab Area (GSSA) was calculated.

GSSA is used as this relates more directly to what can be typically constructed in timber, the superstructure.

The GSSA (Used to define WUI-frame) was calculated as 1592m^2.

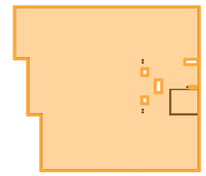
Meanwhile, the Typical Superstructure Slab Area (Used to define WUI-floor) was calculated as 291m^2.

It is important to note that all basement and roof levels are excluded.

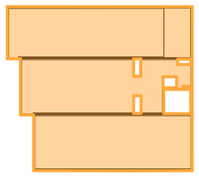
Level 2 areas are based on GSSA either for an individual floor or the sum of all superstructure floors In this example the floor area varies each floor.

The total GSSA includes:
- First floor (as CLT panels supported off a steelwork frame)
- Floors two to four and the roof slab

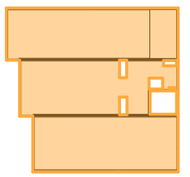
The Second floor is selected as the Typical Floor.



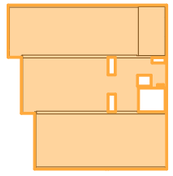
Roof



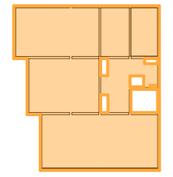
Fourth Floor



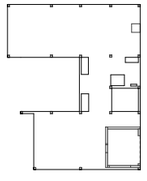
Third Floor



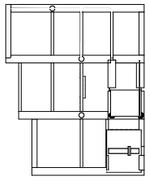
Second Floor



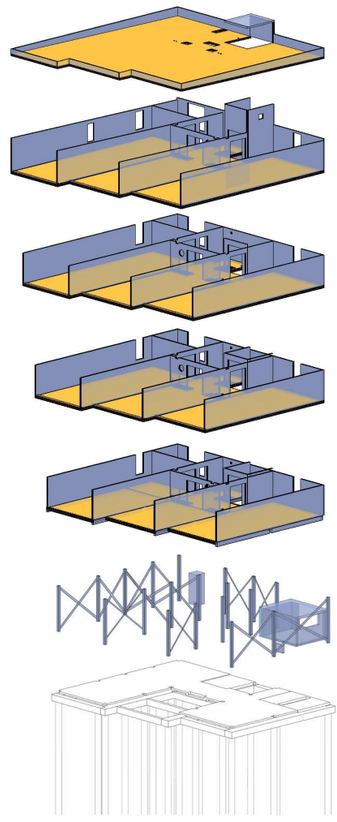
First Floor



Ground Floor



Foundation level



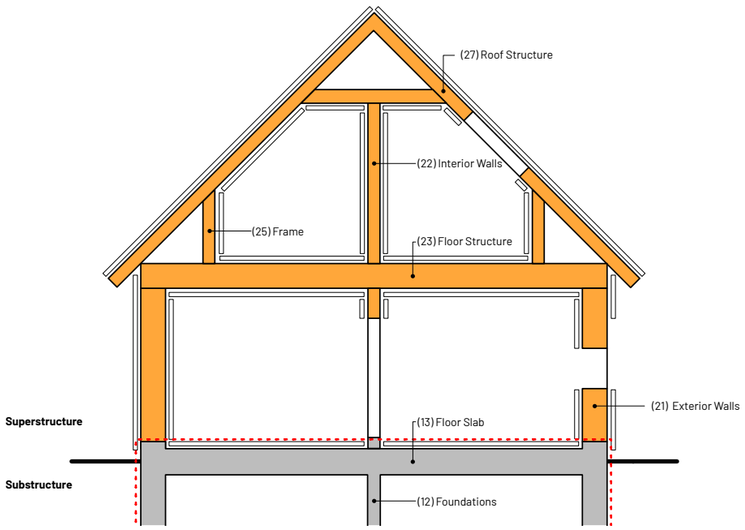
Exploded structural AXO of WorkStack

© dRMM Architects

2. STRUCTURAL ELEMENT CLASSIFICATION

For each element of structure the following information was classified in the BIM model and then extracted.

- **Use**: i.e. lateral horizontal or vertical support system or fixings
- **Type**: Beam, Column Slab, Fixings
- SfB-Category: This allows for classification of elements which can relate to their exposure criteria and location within a structure which will later be used to select the potential use life.
- **Material-Category**: Steel, Timber, Concrete etc.
- **Material-Product**: Mild Steel, CLT, LVL, Plywood, Glulam etc.
- **Material Natural**: Bio or Non-Bio
- **Material-Circularity**: Primary / Secondary / Waste.
- **Material-Source Location**: Local, National, Regional, International



Translated SfB Classification System for Use Life Definitions adapted from BYG-ERFA

3. CALCULATE MASS & VOLUME OF EACH ELEMENT

Volume information of each structural element is taken from the BIM model. This value is then multiplied by the density to calculate the mass of each element.

For material densities we have used those provided in the IstructE carbon tool

Mass (kg) = Material Density (kg/m^3) X Volume (m^3)

E.g. 500 kg =2500 kg/m^3 X 0.2 m^3

If the amount of fixings are not available then this can be estimated. For this project we used 9kg of Steel / m^3 of timber as the fixing quanity was higher than typical. As a default we suggest a value of 7.5 kg / m^3

4. CALCULATE USE RENEWAL RATE OF EACH ELEMENT

A Use Renewal Rate of 0 is applied to all non-bio elements.

For bio elements, the BUILD 2021 table is used to look up the element's minimum and average use life. The appropriate renewal rate for each material is also found from the 'Renewal_lookup' tab in the build 2021 table.

The Minimum and Average URR for each element was calculated by dividing the Minimum or Average Use Time by the Renewal Rate.

Minimum Use Renewal Rate = Minimum Use Time / Renewal Rate

E.g. 0.67 = 60/90

Average Use Renewal Rate = Average Use Time / Renewal Rate

E.g. 1.33 = 120/90

Layer	Use	Type	SfB	Material Category	Material Product	Material Natural	Material Species	Material Circ-Econ	Material Source Location
Superstructure	Horizontal	Wall	17	Concrete	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Wall	22	Concrete	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Slab	23	Concrete	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Beam	12	Concrete	-	Non-Bio	-	Primary	-
Superstructure	Vertical	Wall	22	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Vertical	Wall	21.1	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Horizontal	Slab	23	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Vertical	Wall	27	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Horizontal	Wall	27	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Horizontal	Slab	27	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Vertical	Wall	22	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Horizontal-Typical	Slab	23	Laminated Timber	CLT	Bio	Spruce	Primary	-
Superstructure	Horizontal	Beam	21	Laminated Timber	Glulam	Bio	Spruce	Primary	-
Superstructure	Horizontal-Typical	Beam	21	Laminated Timber	Glulam	Bio	Spruce	Primary	-
Superstructure	Vertical	Wall	21	Masonry	-	Non-Bio	-	Primary	-
Superstructure	Vertical	Beam	21	Masonry	-	Non-Bio	-	Primary	-
Superstructure	Vertical	Core	24	Steel	Galvanised Steel	Non-Bio	-	Primary	-
Superstructure	Vertical	Column	25	Steel	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Beam	21	Steel	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Beam	23	Steel	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Beam	22	Steel	-	Non-Bio	-	Primary	-
Superstructure	Horizontal	Braces	23	Steel	-	Non-Bio	-	Primary	-
Superstructure	Fixings	Fixings	23	Steel	-	Non-Bio	-	Primary	-

Example Structural Element Classification

SfB	Material Category	Material Natural	Material Species	Volume	Material Density	Mass	Volume%	Mass%	Minimum USE TIME	Average USE TIME	RR	Minimum URR	Average URR
17	Concrete	Non-Bio	-	0.2	2500	500.0	0%	0%	60	120	0	0	0
22	Concrete	Non-Bio	-	0.06	2500	150.0	0%	0%	60	120	0	0	0
23	Concrete	Non-Bio	-	4.29	2500	10725.0	1%	3%	60	120	0	0	0
12	Concrete	Non-Bio	-	0.35	2500	875.0	0%	0%	60	120	0	0	0
22	Laminated Timber	Bio	Spruce	75.85	500	37925.0	12%	10%	60	100	90	0.67	1.11
21.1	Laminated Timber	Bio	Spruce	96.98	500	48490.0	15%	13%	60	120	90	0.67	1.33
23	Laminated Timber	Bio	Spruce	259.43	500	129715.0	41%	35%	60	100	90	0.67	1.11
27	Laminated Timber	Bio	Spruce	8.41	500	4205.0	1%	1%	60	120	90	0.67	1.33
27	Laminated Timber	Bio	Spruce	7.17	500	3585.0	1%	1%	60	120	90	0.67	1.33
27	Laminated Timber	Bio	Spruce	76.1	500	38050.0	12%	10%	60	120	90	0.67	1.33
22	Laminated Timber	Bio	Spruce	12.68	500	6340.0	2%	2%	60	100	90	0.67	1.11
23	Laminated Timber	Bio	Spruce	81.17	500	40585.0	13%	11%	60	100	90	0.67	1.11
21	Laminated Timber	Bio	Spruce	2.25	450	1012.5	0%	0%	60	100	90	0.67	1.11
21	Laminated Timber	Bio	Spruce	1.13	450	508.5	0%	0%	60	100	90	0.67	1.11
21	Masonry	Non-Bio	-	1.95	1500	2925.0	0%	1%	60	80	0	0	0
21	Masonry	Non-Bio	-	4.4	1500	6600.0	1%	2%	60	80	0	0	0
24	Steel	Non-Bio	-	2.9	7850	22765.0	0%	6%	60	60	0	0	0
25	Steel	Non-Bio	-	0.8	7850	6280.0	0%	2%	60	120	0	0	0
21	Steel	Non-Bio	-	0.21	7850	1648.5	0%	0%	60	120	0	0	0
23	Steel	Non-Bio	-	1.15	7850	9027.5	0%	2%	60	100	0	0	0
22	Steel	Non-Bio	-	0.08	7850	628.0	0%	0%	60	100	0	0	0
23	Steel	Non-Bio	-	0.01	7850	78.5	0%	0%	60	100	0	0	0
23	Steel	Non-Bio	-	0.60	7850	4716	0%	0%	60	100	0	0	0

Example Calculations of Bio Mass, Volume and Use Renewal Rate

5. CALCULATE BIO

To provide context to the WUI value and to weight the URR the volume and mass of each material is calculated to understand how much % the structure is bio based.

Total Bio Volume = ∑ Volume of all bio based elements
Total Non-Bio Volume = ∑ Volume of all non-bio based elements
Total Volume = Bio Volume + Non-Bio Volume

Percentage of Bio based = (Total Bio Volume / Total Volume) * 100

The following figures are calculated as follows:

6. CALCULATE URR FRAME RANGE

The Minimum Use Renewal Rate was found by calculating the sum of the % mass and Minimum use renewal rate of each element.

∑ (Mass % × Use Renewal Rate)

Minimum URR = $(Mass\%_1 \times URR_1) + (Mass\%_2 \times URR_2) + (Mass\%_3 \times URR_3) ....$

Similarly, the Average Use Renewal Rate was found by calculating the sum of the % mass and Average use renewal rate of each element.

Average URR = $(Mass\%_1 \times URR_1) + (Mass\%_2 \times URR_2) + (Mass\%_3 \times URR_3) ....$

WUI-Frame = Total Bio Volume of Structural Elements / GCFA Frame (m^2)

WUI-Frame = 621.2 m^3/ 1592 m^2

WUI-Floor = Total Bio Volume of Structural Elements / CFA Floor (m^2)

WUI-Floor = 82.3 m^3/ 312 m^2

WUI-Frame (m^3/m^2)	0.39	
Total Bio Volume (m^3)	621.2	
Total Bio Volume (%)	97.4	
URR Frame Range	0.54	0.95
	Minimum URR	**Average URR**
WUI-Floor (m^3/m^2)	0.26	
Floor Bio Volume (m^3)	82.3	
Floor Bio Volume (%)	100.0	

Example Output Calculations

FURTHER INFORMATION

In addition to this project summary report, other information and datasets are available through the University of Stuttgart's data repository, DaRUS and through the TDUK and Built by Nature's websites.

DATA SUBMISSION

If you would like to contribute additional data to this project please complete the follow the guidance in this document and complete the data form at this location: https://airtable.com/appT7MnQnpFCtoxQk/pagZXTqI5hVPo7ERM/form

DATA EXPLORATION PLATFORM

Available at: https://architools.drawingtable.net/UWW/

This visualisation platform includes a selection of charts for better exploration and understanding of the undertaken work than from static representation alone. Users can explore the metric results and project data, search and filter by different criteria such as sector, framing type, height or location.

A. Ogle, H. Svatoš-Ražnjević, and A. Campbell, Using Wood Well: Interactive Tools for Analysing Timber Usage and Material Composition in Construction Projects. 2026. [Online].

SUMMARY REPORT

Available at: https://doi.org/10.18419/opus-19343

This document summaries the results of the Using Wood Well project, a research collaboration between Change Building, the Institute for Computation Design and Construction (ICD) at the University of Stuttgart, and Waugh Thistleton Architects, funded by Built by Nature. The project investigated how timber is used in construction with the aim of improving material use and supporting circulation economy principles in terms of the design of timber buildings.

A. Campbell, H. Svatoš-Ražnjević, and A. Ogle, Using Wood Well: Building within Nature's Limits. Stuttgart, Germany: ICD, University of Stuttgart, Change Building, Waugh Thistleton Architects, 2026. doi: 10.18419/OPUS-19343.

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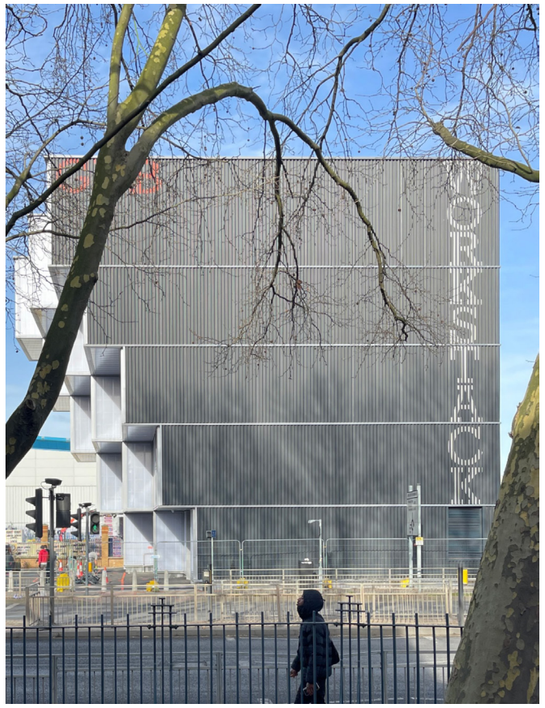
WORKSTACK

Charlton, UK

2023

LEVEL 2 - FRAME

WUI_{FLOOR} / WUI_{FRAME} / URR_{FRAME}



Exterior
© dRMM/Alex de Rijke



Interior
© dRMM/Alex de Rijke

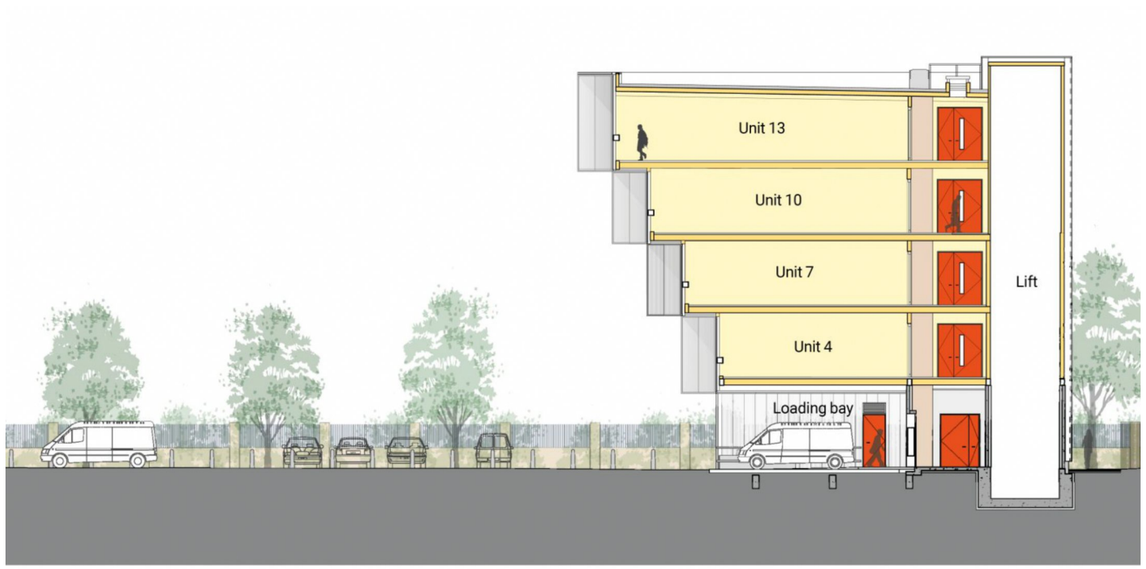
PROJECT DESCRIPTION

WorkStack was designed as a new model for high density industrial space on compact sites. Located in Charlton and developed for the Greenwich Enterprise Board (GEB), it addresses the twin pressures of rising land values and a growing need for high-quality industrial space within cities. Designed to be affordable to rent, operate and maintain, these workshops encourage manufacturing in central London.

The building is a five-storey stacked structure on a compact 1,426 m2 site, enabling 14 units (each between 55–110 m2)and workspace for about 60 people. This delivers an employee density of 428 per hectare — far above London's industrial average of 69. Occupiers include furniture makers, knitwear producers, workwear manufacturers and a bicycle/motorcycle workshop.

WorkStack uses engineered mass timber (CLT) for load bearing walls and slabs. The structure, with its stacked-bay organisation and cantilevered floorplates, gives the building a strong presence on the main road, while also providing solar shading and creating a covered delivery space. Organised in a simple and functional manner there are three units per floor, forming three structural bays stacked over five floors. Two lifts provide the primary access to the upper floors for goods and tenants whilst a staircase is located to the inside of the eastern façade.

The panelised CLT structure sequesters approximately 343 tonnes of carbon, achieving about 21% less upfront embodied carbon than the London Energy Transformation Initiative (LETI) 2030 embodied carbon target of 350 kg CO2/m2 and 44% less than RIBA's 2030 Built Target for whole life carbon (of 750 kgCO2 /m2).



Section

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WUI_{FRAME}

0.39
m³/m²
0 1

BIO

97%
VOLUME %

WUI_{FLOOR}

0.26
m³/m²
0 1

URR

0 2
0.54 – 0.95
Use / Growth

STRUCTURE TYPE
Panel

MATERIAL
All-Timber

ENGINEERED WOOD
CLT

SPECIES
Spruce

GSSA
1601 m²

TIMBER VOLUME
621 m³

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