

“Strategies for a Climate-Neutral Building Stock”
Applied Eco-Balance and Best Practice

Practice and Challenges of Decarbonized Design



OBAYASHI

MAKE BEYOND

TRANSCENDING THE ART AND SCIENCE OF MAKING OF THINGS

Sho Ito



MAKE BEYOND

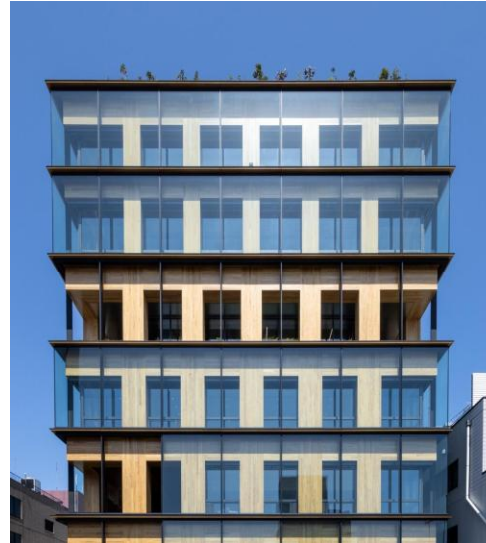
TRANSCENDING THE ART AND SCIENCE OF MAKING OF THINGS

Building the TOKYO SKYTREE®

The tallest broadcasting tower in the world



Sustainable Design



2006 - present : Obayashi Corporation
2013 - 2015 : Ingenhoven Architects
2004 - 2006 : Graduate School of Engineering, Kyoto University



All Timber

All the main structural component are made of timber

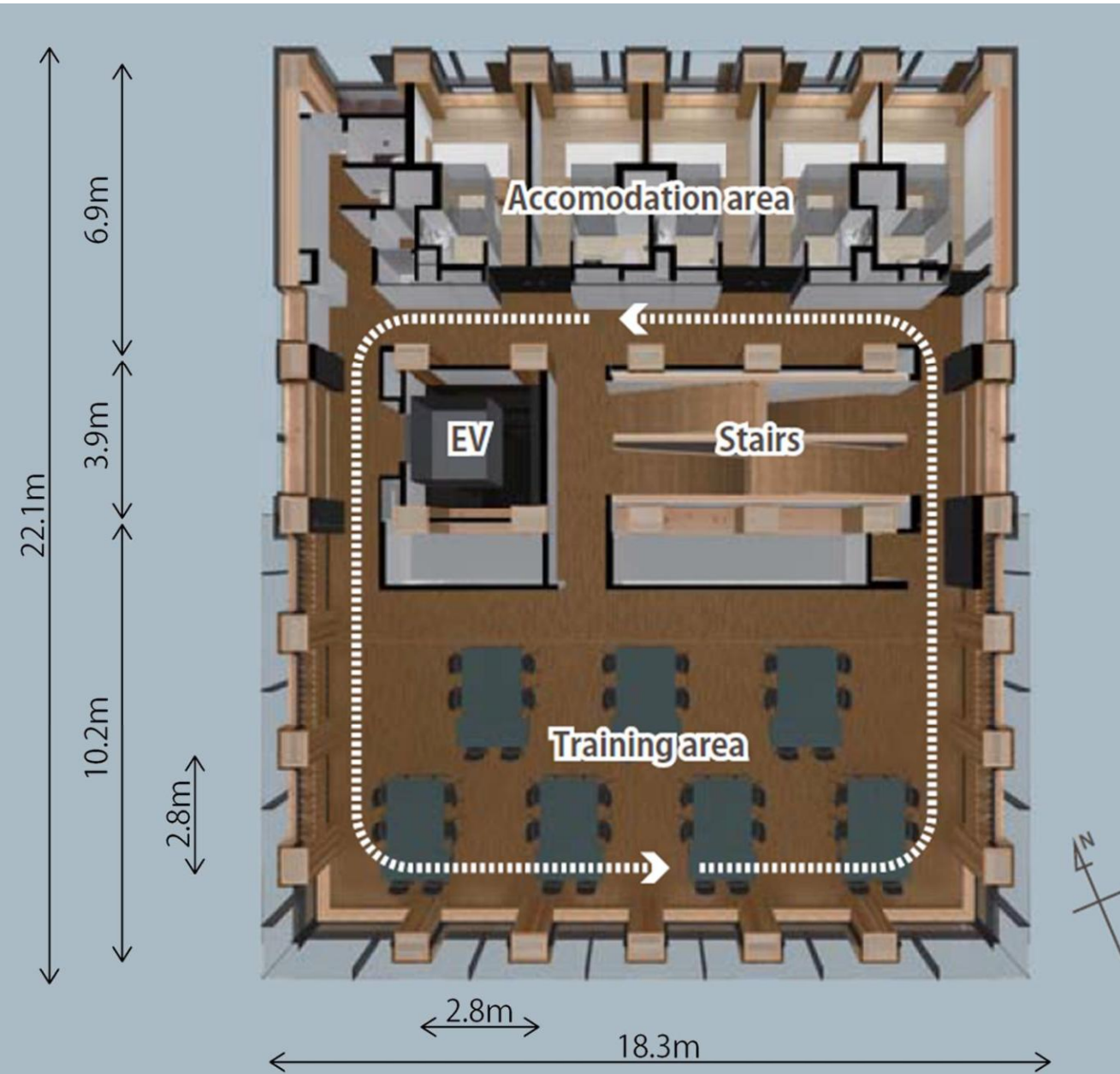


1. Overview of Port Plus
2. Results of LCA in Port Plus
3. LCA Issues from the Designer's Perspective





- **Site area**
565m²
- **floor area**
350m²
- **Total floor area**
3,500m²
- **Structure**
11 stories above ground, 1 story underground
- **Construction Period**
March 2020 – March 2022
- **Subsidy of approx. 330 million yen :**
Sustainable Building Leadership Project
Demonstration Project for Building Utilizing CLT



Challenges in realizing all timber high-rise building

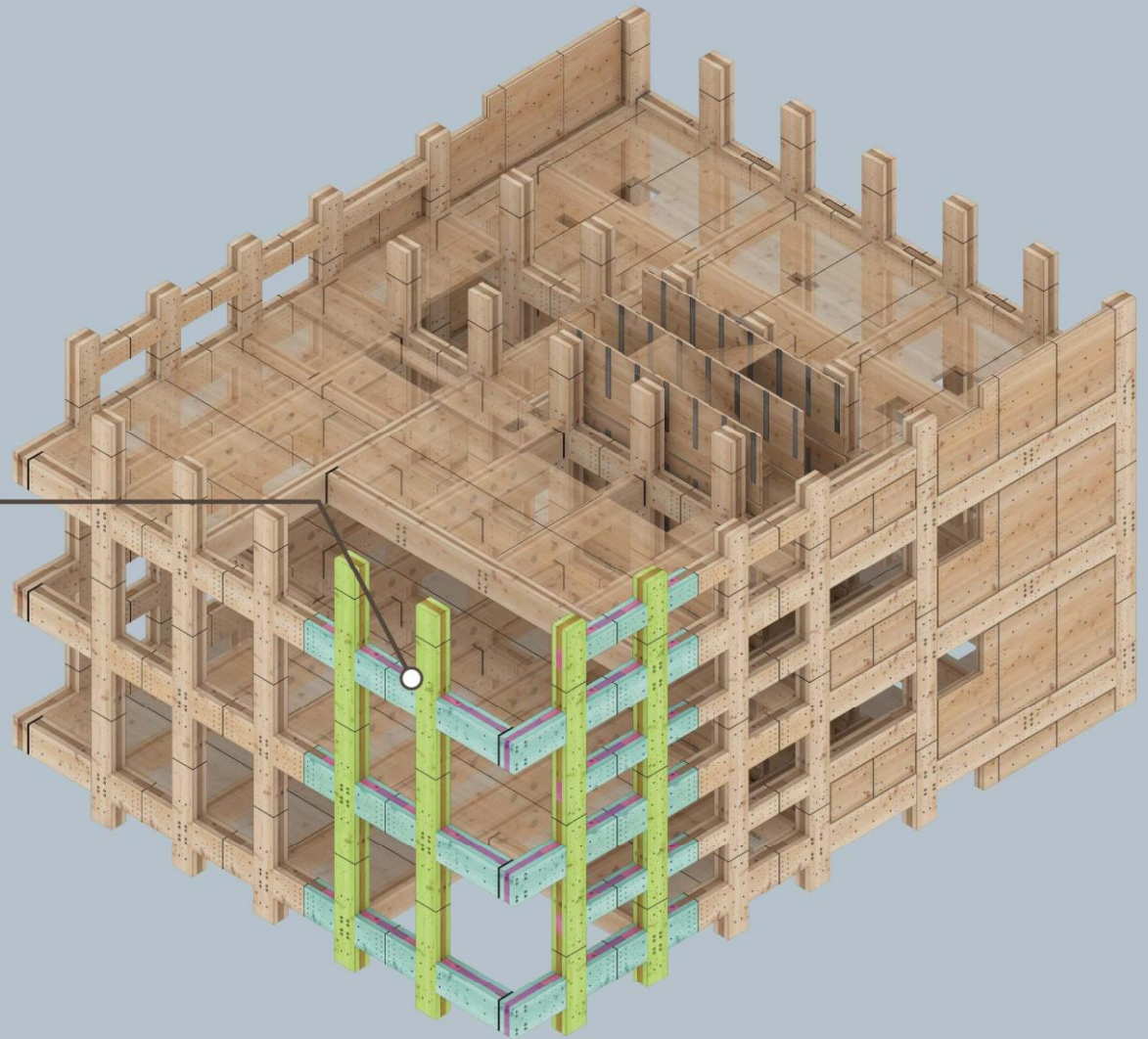
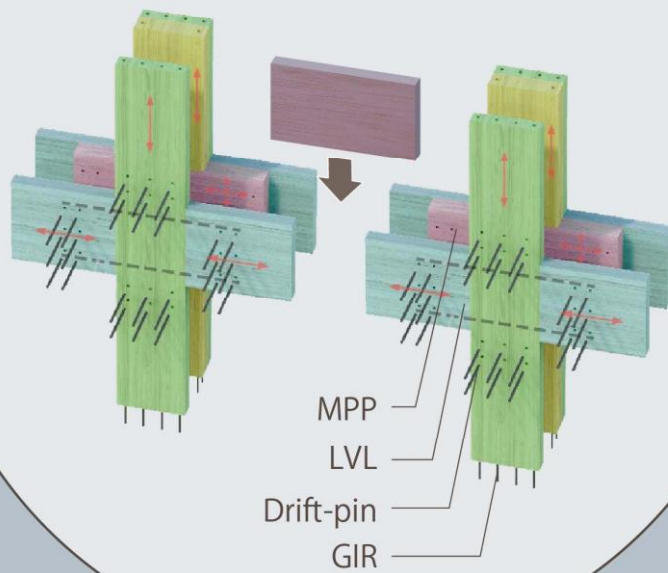
Earthquake Resistance

×

Fire Resistance



Rigid Cross Joint





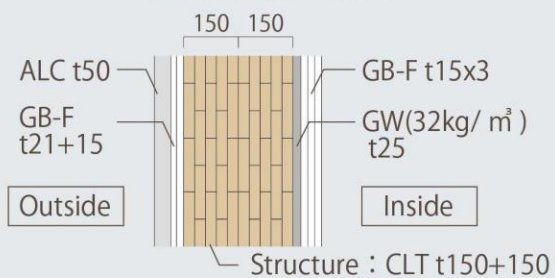
Challenges in realizing all timber high-rise building

Earthquake Resistance

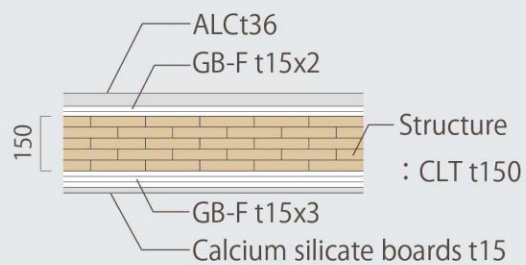
×

Fire Resistance

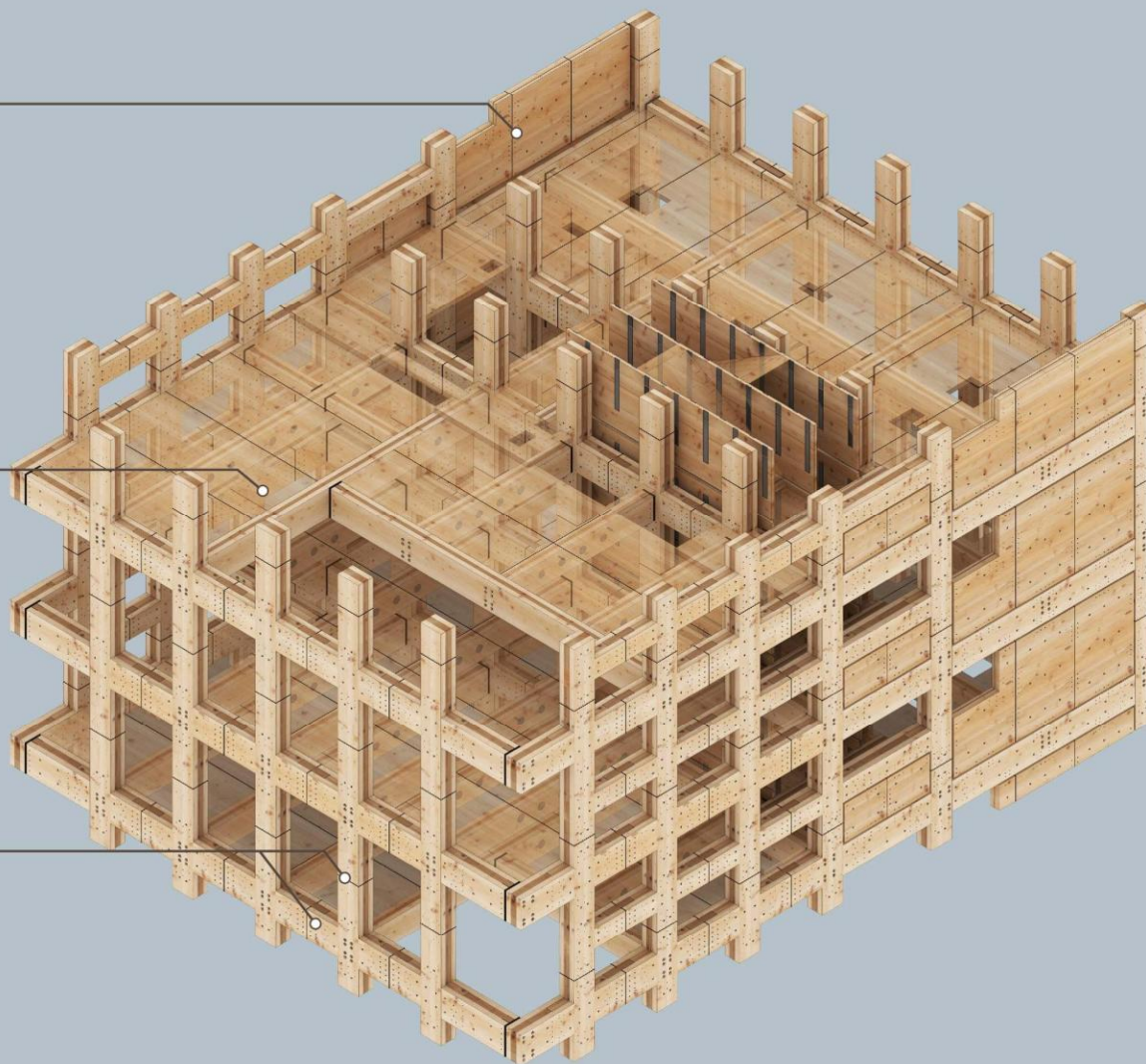
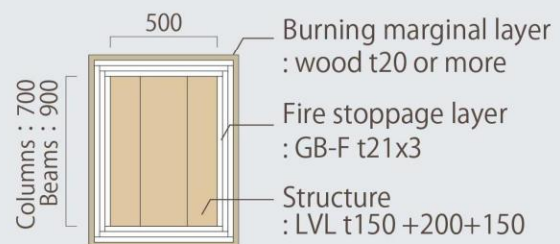
Exterior wall



Floor



Columns and beams - Omega wood -



3,350 t-CO₂

Carbon Offset in Port Plus

CO₂ Reduction

1,700t CO₂

Compared with steel structure

*Approximate value by One Click LCA

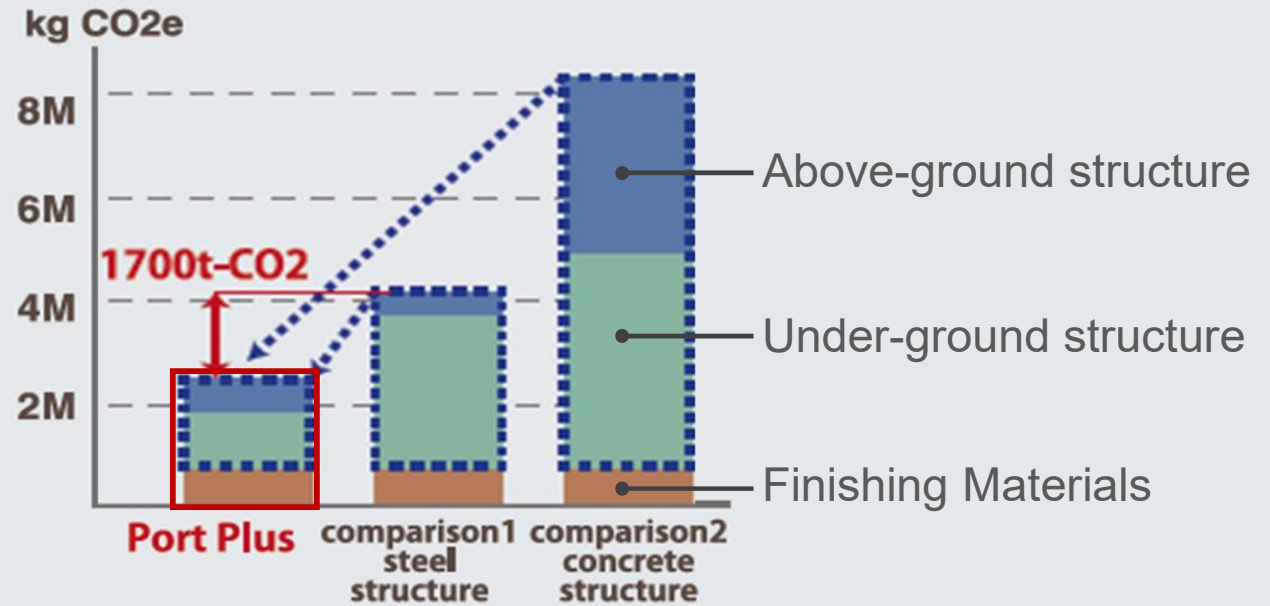
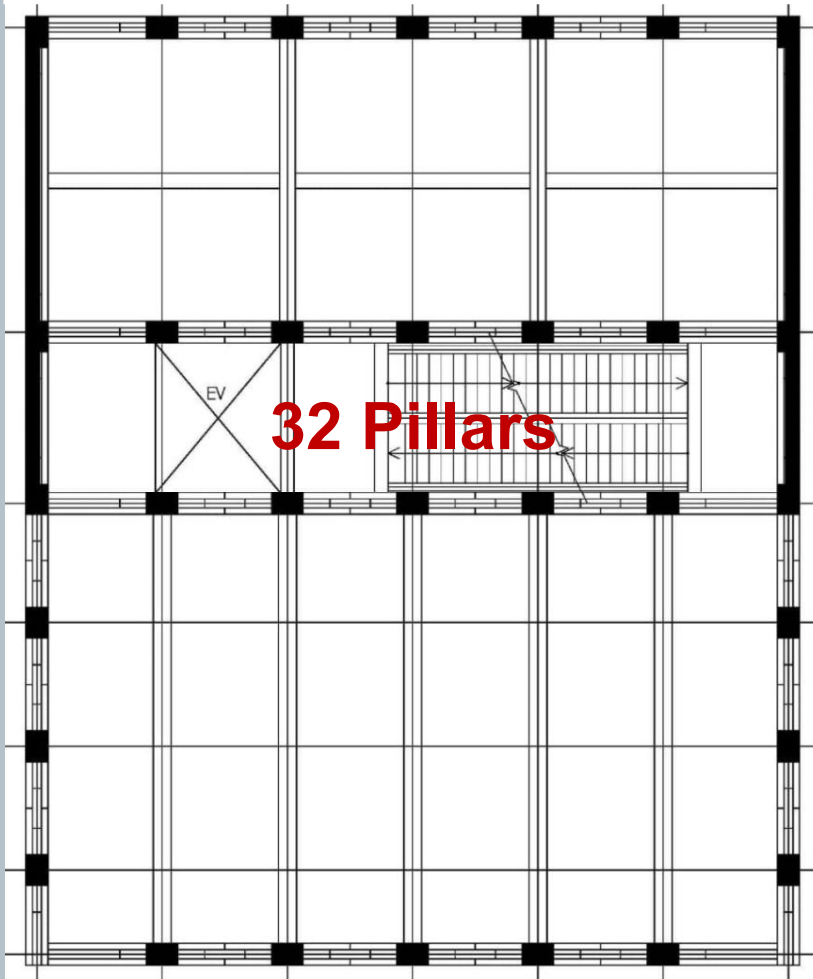
+

Biogenic carbon storage

1,650t CO₂

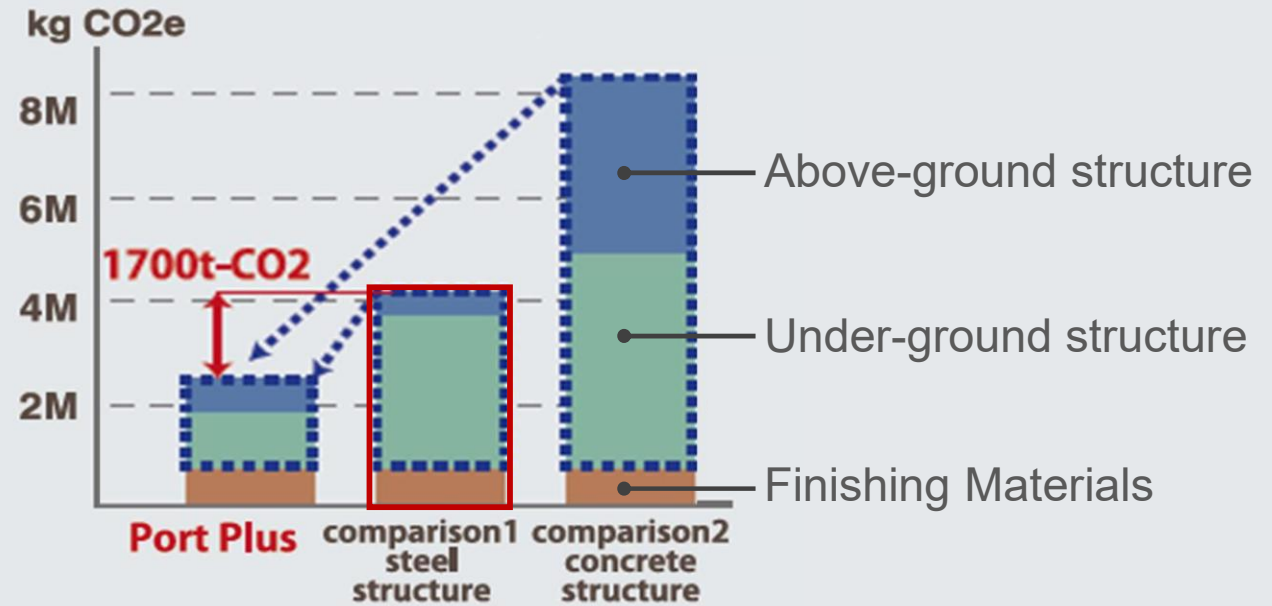
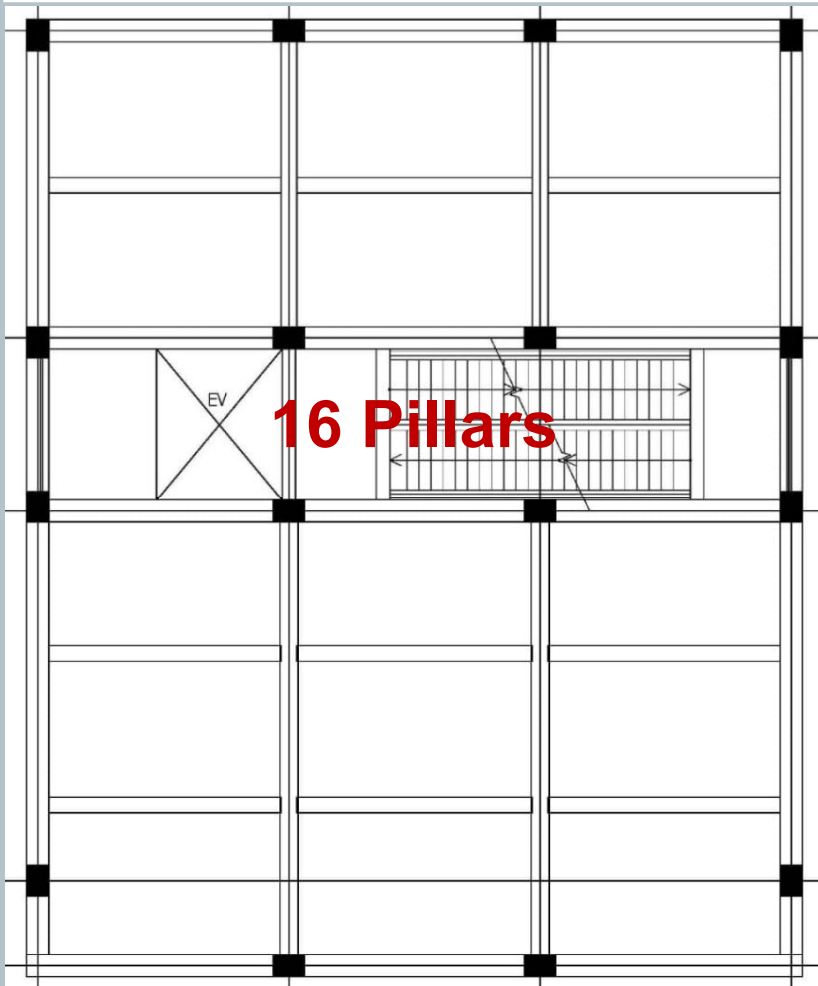
*Simple trial calculation by a calculation sheet released by the Forestry Agency

Port Plus All Timber Structure



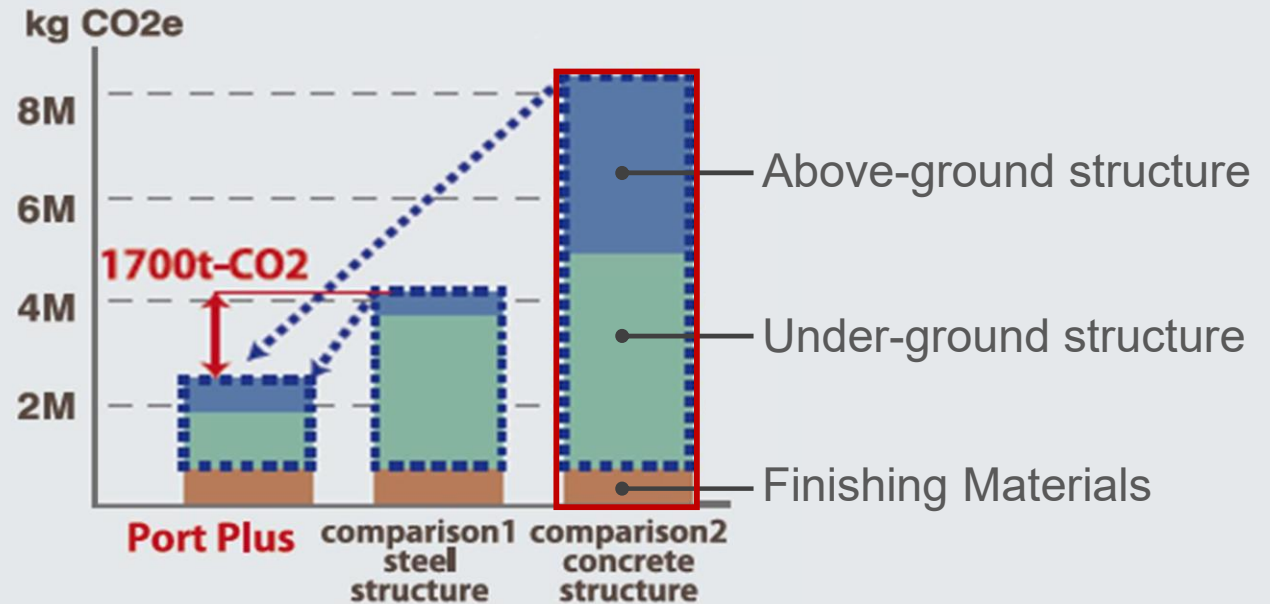
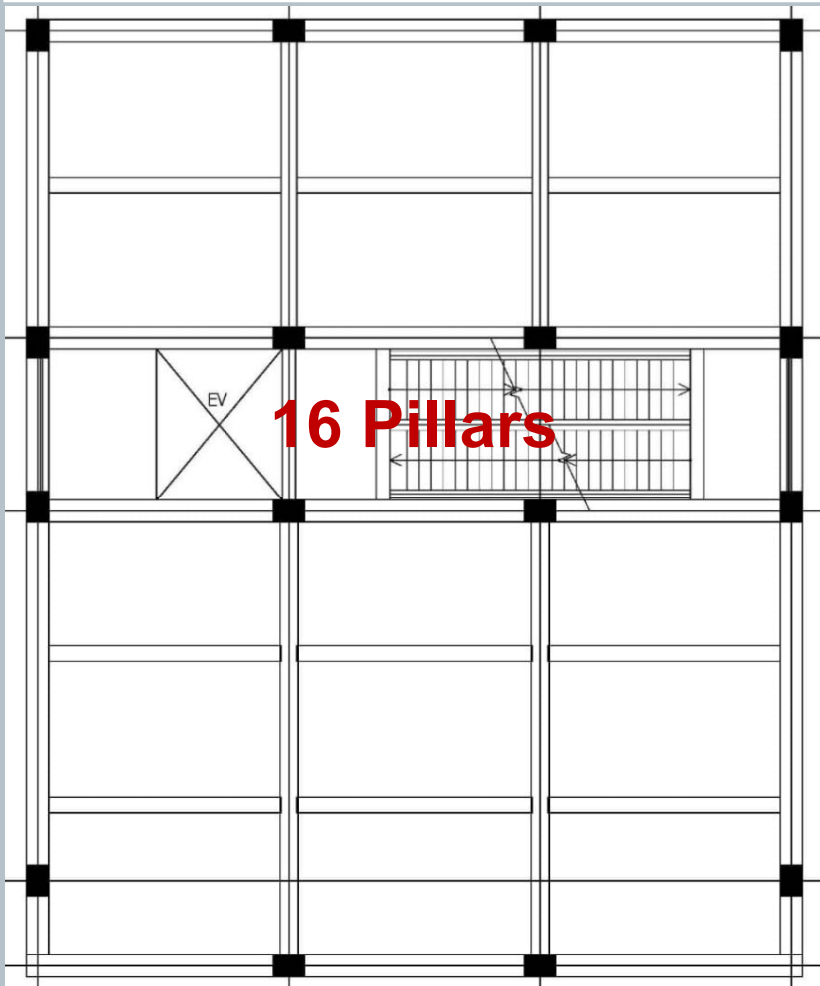
- * Construction period : **23.5 months**
- * with short-stroke seismic isolation system
- * Main column size (timber): □700×500mm
- Main beam size (timber) : □900×500mm
- * Slab & roof thickness (timber) : 150mm
- * Floor height : 4000mm

Comparison 1 Steel Structure



- * Construction period : **21.0 months**
- * with short-stroke seismic isolation system
- * Main column size (steel): $\square 550 \times 550 \text{mm}$
Main beam size (steel) : $\text{H}700 \times 300 \text{mm}$
- * Slab & roof thickness (Concrete) : 210mm
- * Floor height : 4000mm

Comparison 2 Concrete Structure



- * Construction period : **32.5 months**
- * with short-stroke seismic isolation system
- * Main column size (concrete): $\square 850 \times 850 \text{mm}$
Main beam size (concrete) : $\square 900 \times 500 \text{mm}$
- * Slab & roof thickness (Concrete) : 210mm
- * Floor height : 4000mm

Amount of wood used

1,990 m³

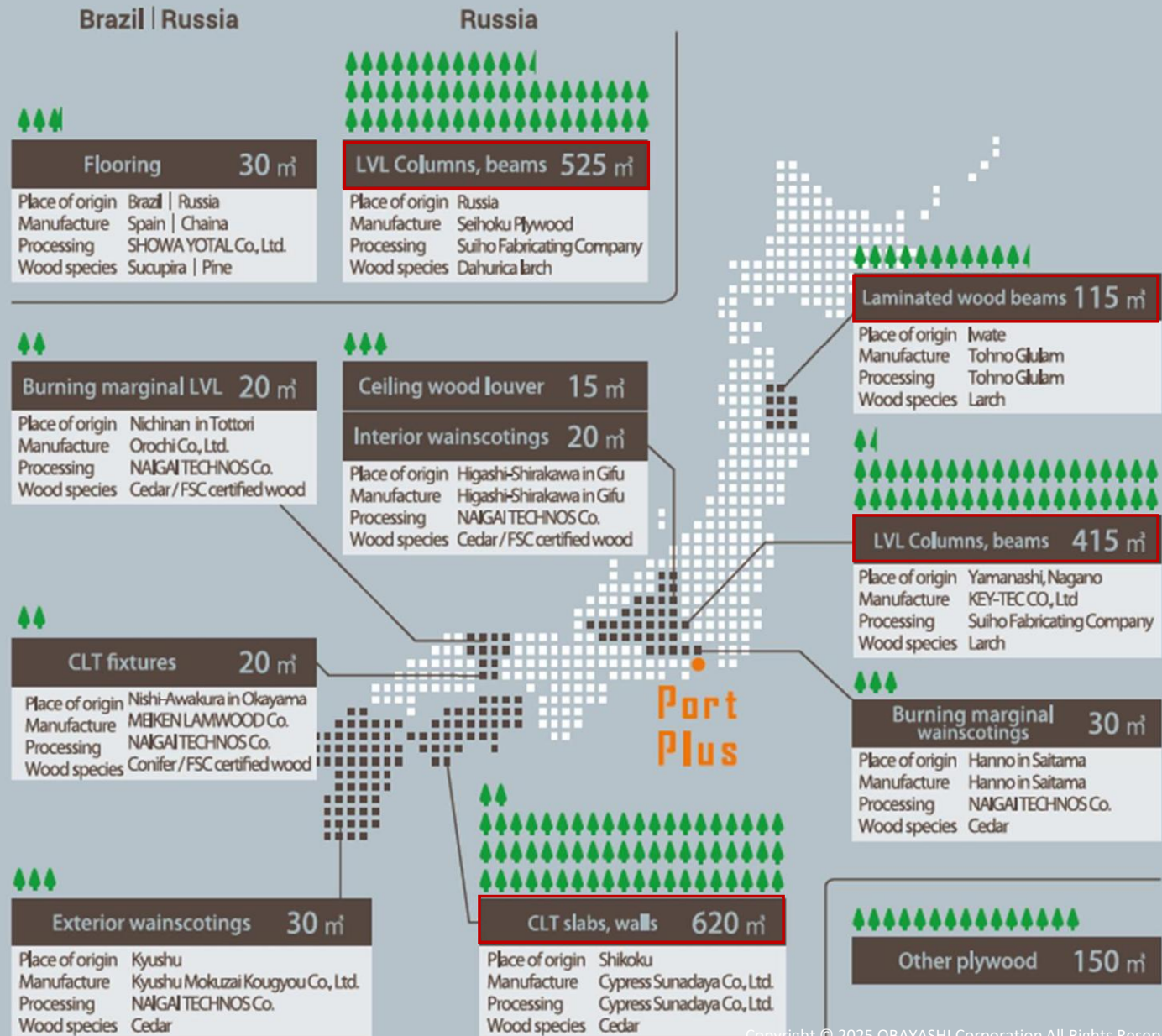
Structure : 1,675 m³

Interior material : 315 m³

Biogenic carbon storage

1,650t CO₂

*Simple trial calculation by a calculation sheet released by the Forestry Agency



3,350 t-CO₂

Carbon Offset in Port Plus

CO₂ Reduction

1,700t CO₂

Compared with steel structure

*Approximate value by One Click LCA

+

Biogenic carbon storage

1,650t CO₂

*Simple trial calculation by a calculation sheet released by the Forestry Agency

Why a Life Cycle Assessment at Port Plus?



×



Which LCA tool was used?

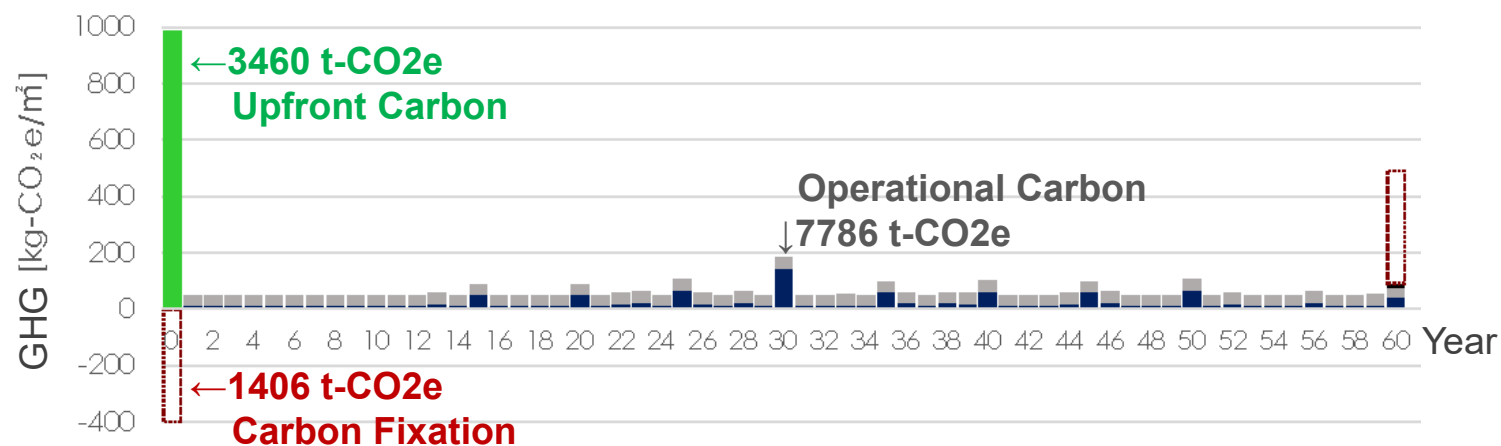
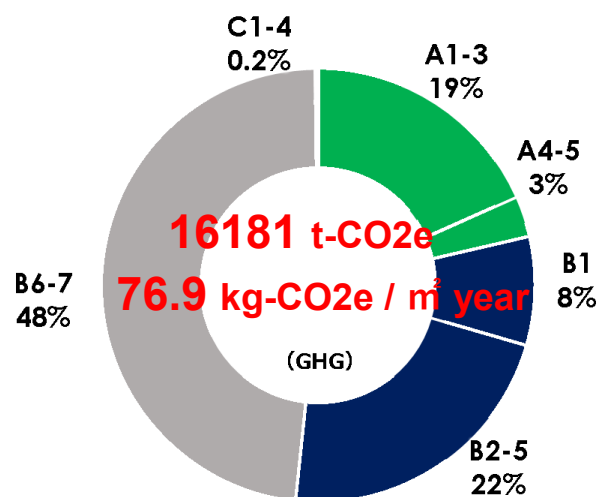
Stage calculated by One Click LCA

WHOLE LIFE CARBON ASSESSMENT INFORMATION															
PROJECT LIFE CYCLE INFORMATION											SUPPLEMENTARY INFORMATION BEYOND THE PROJECT LIFE CYCLE				
[A1 – A3]			[A4 – A5]		[B1 – B7]					[C1 – C4]				[D]	
PRODUCT stage			CONSTRUCTION PROCESS stage		USE stage					END OF LIFE stage				Benefits and loads beyond the system boundary	
[A1]	[A2]	[A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[C1]	[C2]	[C3]	[C4]		
Raw material extraction & supply	Transport to manufacturing plant	Manufacturing & fabrication	Transport to project site	Construction & installation process	Use			Repair	Replacement	Refurbishment	Deconstruction Demolition	Transport to disposal facility	Waste processing for reuse, recovery or recycling	Disposal	Reuse Recovery Recycling potential
					[B6] Operational energy use										
[B7] Operational water use															

Stage calculated by J-CAT

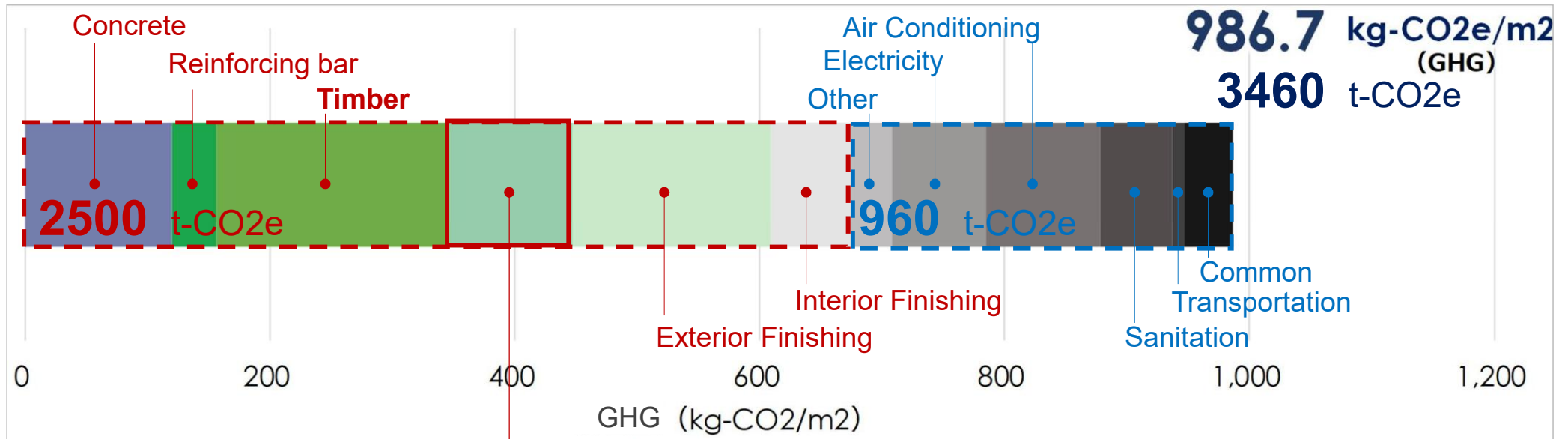
WHOLE LIFE CARBON ASSESSMENT INFORMATION														
PROJECT LIFE CYCLE INFORMATION											SUPPLEMENTARY INFORMATION BEYOND THE PROJECT LIFE CYCLE			
[A1 – A3]			[A4 – A5]		[B1 – B7]					[C1 – C4]				[D]
PRODUCT stage			CONSTRUCTION PROCESS stage		USE stage					END OF LIFE stage				Benefits and loads beyond the system boundary
[A1]	[A2]	[A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[C1]	[C2]	[C3]	[C4]	
Raw material extraction & supply	Transport to manufacturing plant	Manufacturing & fabrication	Transport to project site	Construction & installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction Demolition	Transport to disposal facility	Waste processing for reuse, recovery or recycling	Disposal	Reuse Recovery Recycling potential
					[B6] Operational energy use									
[B7] Operational water use														

Results of LCA by J-CAT



kg-CO ₂ e / m ² year	stage					Total	Ratio
	Product	Construction	Use		End of Life		
	A1-A3	A4-A5	B1-B5	B6-B7	C1-C4		
Architecture	10.3	1.5	2.3	0.0	0.2	14.3	18.6%
Electric & Solar	1.2	0.1	2.8	37.0	0.0	54.6	71.0%
Air Conditioning	1.5	0.1	6.4		0.0		
Sanitation	0.9	0.0	3.9		0.0		
Transportation	0.2	0.0	0.5		0.0		
Common	0.0	0.7	0.7			1.3	1.7%
Maintenance			0.4			0.4	0.5%
CFC leak			6.2			6.2	8.1%
Total	14.1	2.3	23.3	37.0	0.2	76.9	100.0%
Ratio	18.3%	3.1%	30.3%	48.1%	0.2%	100.0%	

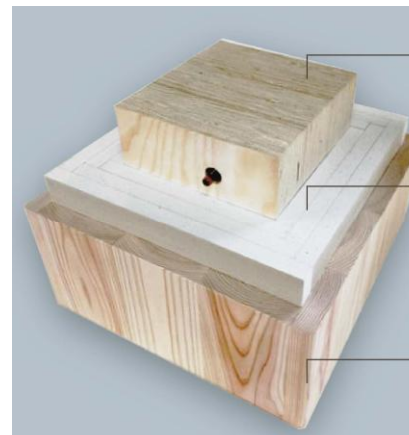
Analysis of Upfront Carbon



Fire-proof Layer : Gypsum Boards

10% of total upfront carbon

* Gypsum Boards : 72 kg CO₂e / m²



Structure : Timber

Fire-proof layer : Gypsum Boards

Burning marginal layer : Timber



LCA Issues from the Designer's Perspective

1. Development of EPDs for building materials, leading to carbon pricing
2. Decarbonization decisions support for clients in the SD phase
3. Evaluation of decarbonization after End of Life (C1-C4) Stage

1. Development of EPDs for building materials, leading to carbon pricing



Environmental Product Declaration

According to ISO 14025 and EN 15804+A1 for:

EGO-CLT Cross Laminated Timber wood panel

Programme	The International EPD® System www.environdec.com
Programme operator	EPD International AB
EPD Registration number	S-P-01314
Published	2018-05-23
Valid until	2023-05-18
Type of EPD	Cradle-to-grave
Product Category Rules	PCR 2012:01 - Construction products and construction services, Ver. 2.2 Sub-PCR. Wood and wood-based products for use in construction





エコリーフ
タイプⅢ 環境宣言 (EPD)
登録番号: JR-AC-18003E

JEMAI環境ラベルプログラム
一般社団法人産業環境管理協会
東京都千代田区綾町2-2-1
<https://www.jemai-label.jp>



安全で快適な住空間を創る
YOSHINO
吉野石膏株式会社
Yoshino Gypsum Co.,Ltd

強化せっこうボード (GB-F) タイガーボード・タイプ Z、タイガーボード・タイプ Z-WR (21mm厚)

Fire-Resistant Gypsum Board (GB-F) Tiger Board Type Z, Tiger Board Type Z-WR (Thickness:21mm)



算定単位

1㎡

算定対象段階

☐最終財 ☒中間財

製造段階 (原料調達・原料輸送・生産)

製品の型式、主要仕様・諸元

型式:

製造工場: 千葉第一工場

●強化せっこうボード (GB-F)	
厚さmm	21
単位面積当たりの質量 kg/㎡	15.0~20.4
密度 g/cm³	0.75~0.95
含水率%	5以下
曲げ破壊強度 N/㎡	長さ方向 800N/㎡以上 幅方向 200N/㎡以上
耐衝撃性	10mmの直径の落下球を1m以下から、垂直に落下させたとき、破損を来さないこと。
耐火性能	耐火性能 180分
難燃性能	難燃性能 180分
吸音性	吸音性 0.85
熱伝導率 W/mK	0.08以下

問い合わせ先

吉野石膏株式会社 品質保証室
<http://yoshino-gypsum.com/>
電話:03-3890-4111

登録番号	JR-AC-18003E
適用PCR番号	PA-178200-AC-01
PCR名	せっこうボード製品 (中間財)
公開日	2018年6月1日
検証合格日	2018年4月27日
検証方式	個別検証方式
検証番号	JV-AC-18003E
検証有効期間	2023年4月26日
PCRレビューの実施	
認定日	2018年 2月 15日
委員長	神崎 昌之 (一般社団法人産業環境管理協会)
第三者検証者*	
外部検証員	柿原 由美子
ISO14025およびISO21930に準じた 本宣言及びデータの独立した検証	
<input type="checkbox"/> 内部 <input checked="" type="checkbox"/> 外部	

登録番号: JR-AC-18003E

2. Decarbonization decisions support for clients in the SD phase

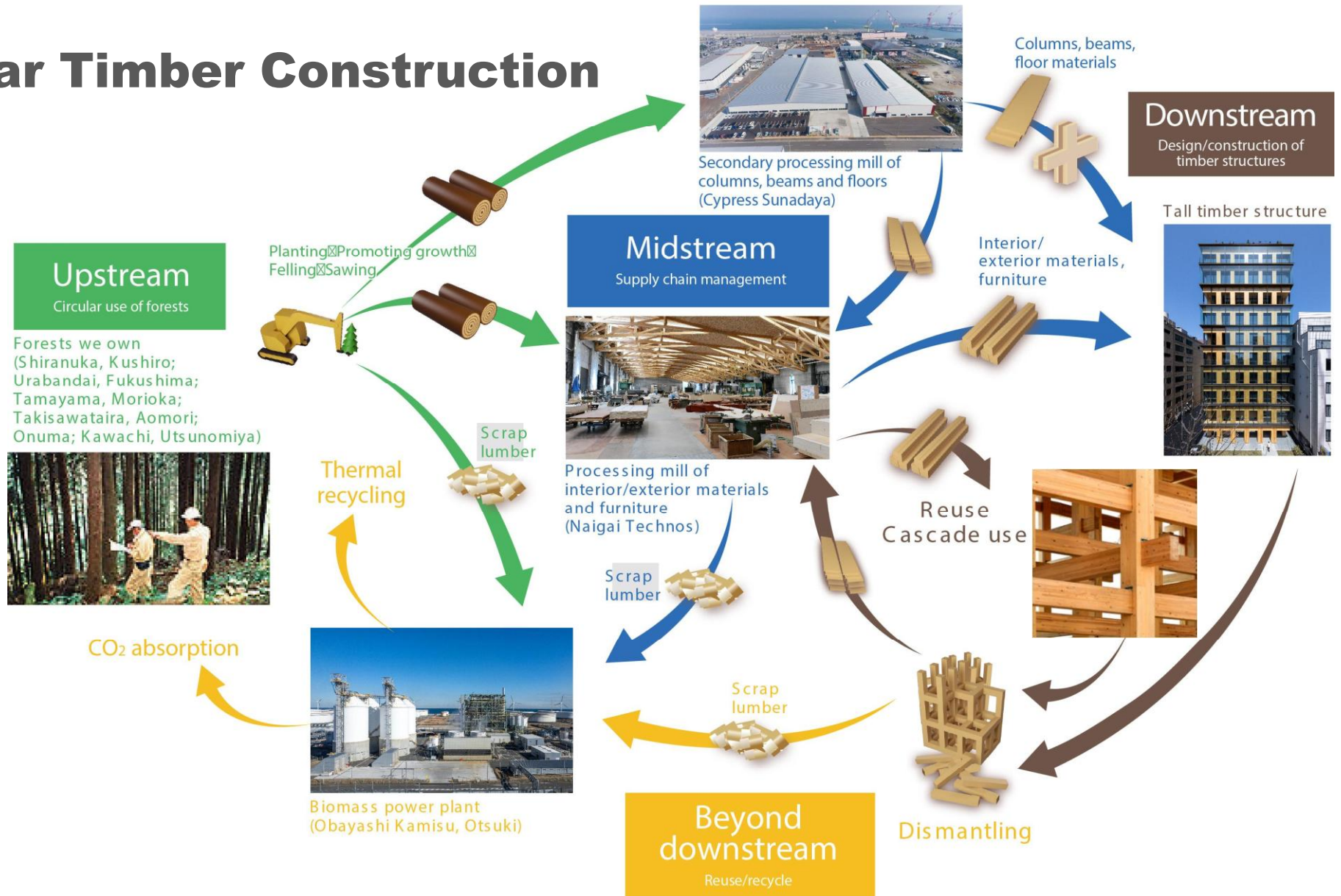


Life Cycle Visualizer | JOCOTAI

3. Evaluation of decarbonization after End of Life (C1-C4) Stage

WHOLE LIFE CARBON ASSESSMENT INFORMATION																
PROJECT LIFE CYCLE INFORMATION											SUPPLEMENTARY INFORMATION BEYOND THE PROJECT LIFE CYCLE					
[A1 – A3]			[A4 – A5]		[B1 – B7]					[C1 – C4]						
PRODUCT stage			CONSTRUCTION PROCESS stage		USE stage					END OF LIFE stage						
[A1]	[A2]	[A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[C1]	[C2]	[C3]	[C4]			
Raw material extraction & supply	Transport to manufacturing plant	Manufacturing & fabrication	Transport to project site	Construction & installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction Demolition	Transport to disposal facility	Waste processing for reuse, recovery or recycling	Disposal			
					[B6] Operational energy use											
					[B7] Operational water use											
											[D]					
											Benefits and loads beyond the system boundary					
											Reuse Recovery Recycling potential					

Circular Timber Construction



“Strategies for a Climate-Neutral Building Stock”
Applied Eco-Balance and Best Practice

Practice and Challenges of Decarbonized Design



MAKE BEYOND
TRANSCENDING THE ART AND SCIENCE OF MAKING OF THINGS

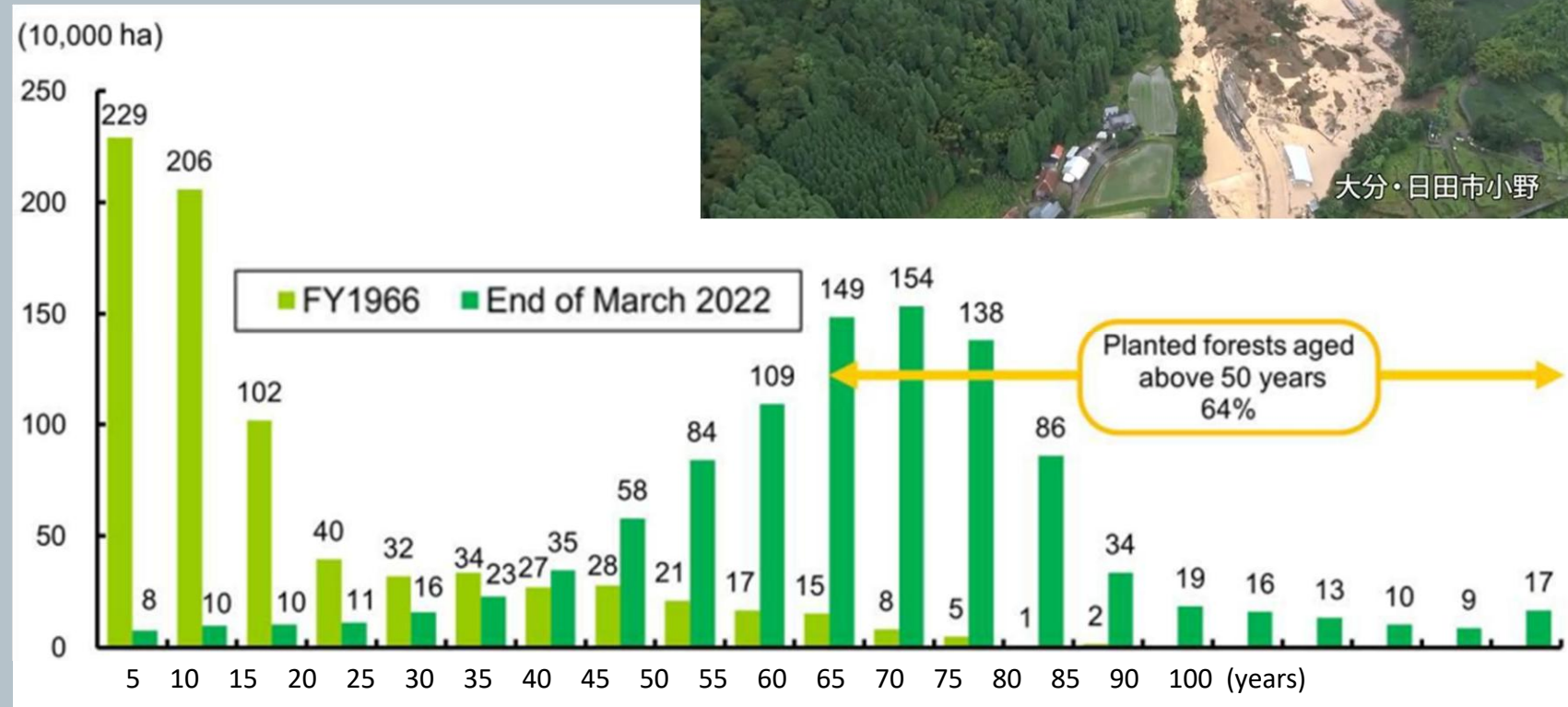
Sho Ito



Appendix

Requirement to use “**MORE**” wood in mid or high-rise buildings

Area of planted forest age

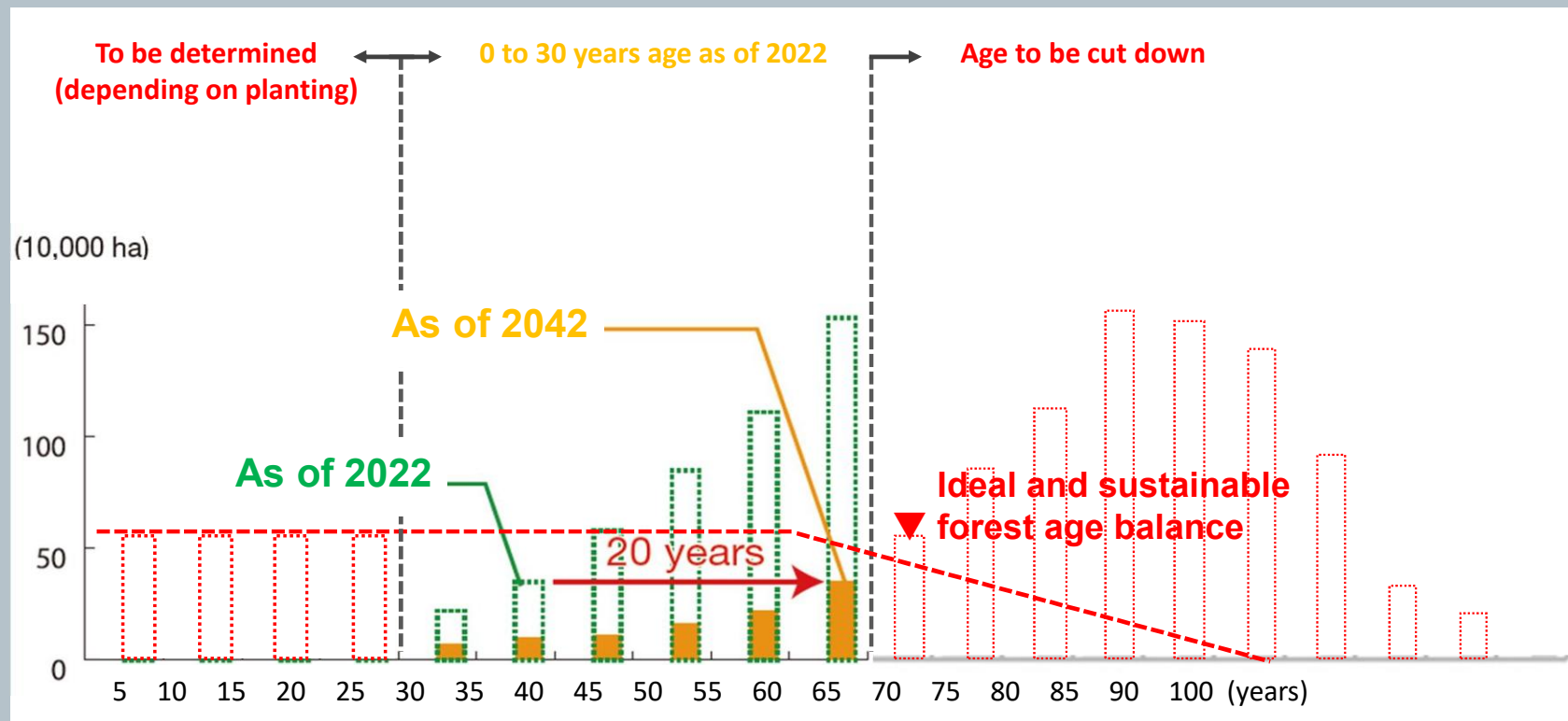


Requirement to keep wood in buildings “**LONGER**”



DfD | Design for Deconstruction

Area of planted forest age as of 2042



Wood “Grand Ring” of the EXPO 2025

OsM | Offsite Manufactured

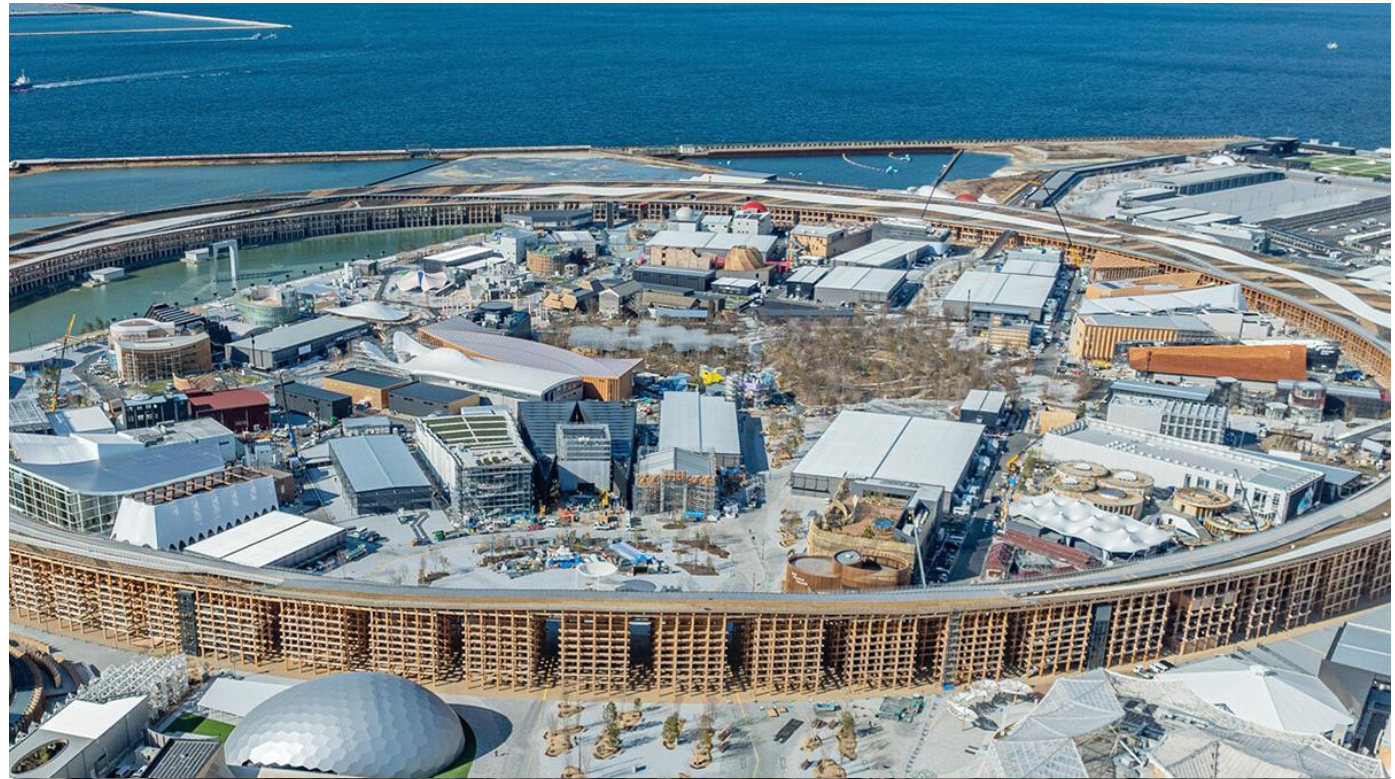


DfD | Design for Deconstruction

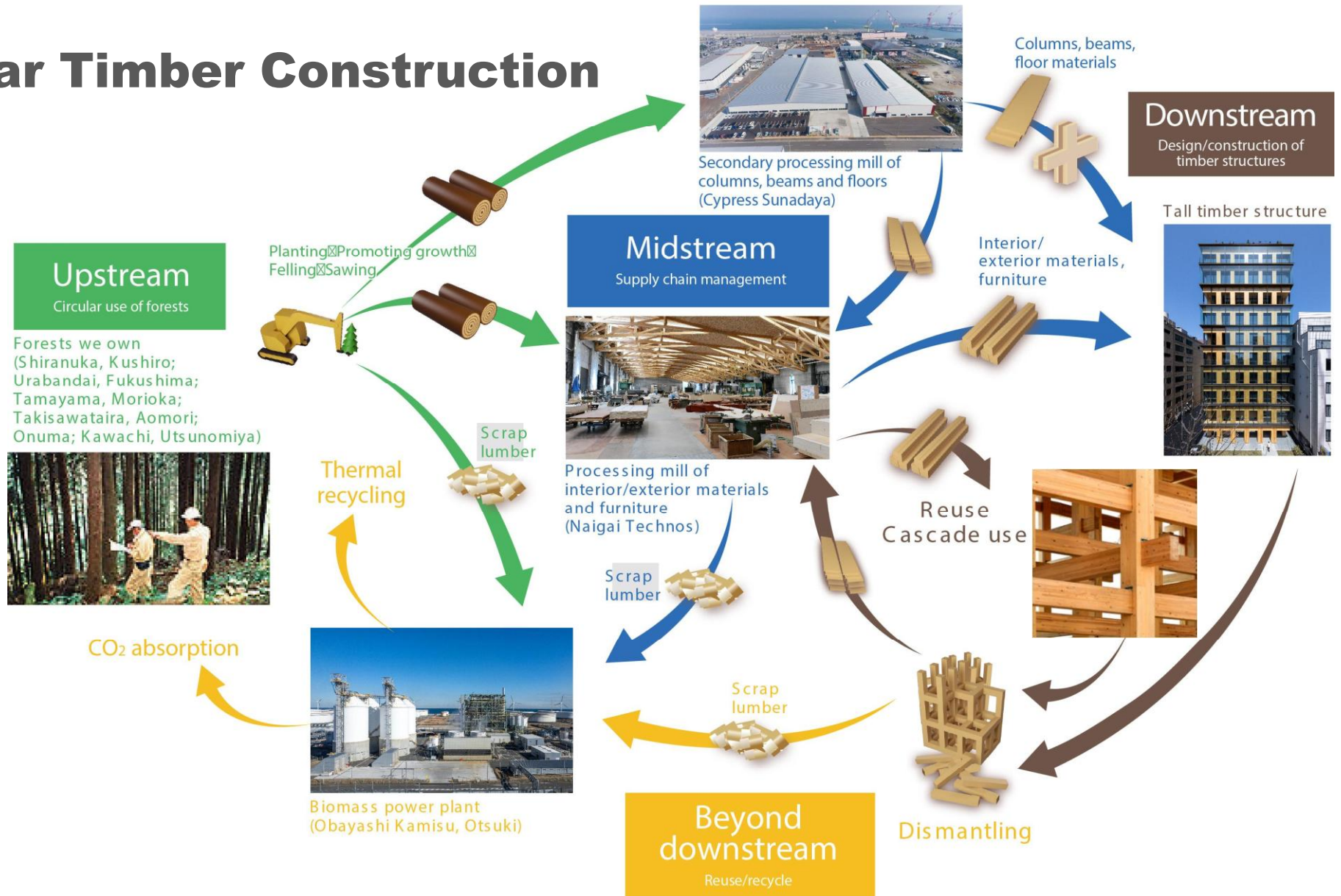


EoL | End of Life Scenarios

BaMB | Building as Material Bank



Circular Timber Construction



Circular Timber Construction Report

—Mass timber strategy and quantitative analysis for “more” and “longer” use of wood—

Yosuke Komiyama (Kyoto University)

Sho Ito, Shun Takayama, and Mari Ota (Timber Design and Construction Department, Obayashi Corporation)

March 2023

Table of Contents

- Chapter 0 : Value Created by Circular Timber Construction and Its Issues
- Chapter 1 : Upstream analysis
—Ideal Forestry Resources To Be Supplied from Mountains—
- Chapter 2 : Analysis of Relationship between Upstream and Downstream
—Quantitative Consistency between Supply and Demand—
- Chapter 3 : Downstream Analysis
—Material Characteristics of Timber required in Tall Timber—
- Chapter 4 : Issues of Location in Wood Distribution System
—Streamlining Processing and Distribution of Resources—
- Roundtable : A conversation with Dr. Mariko Yamasaki (Nagoya University) and
Dr. Yutaka Goto (Chalmers University of Technology/Tohoku University)
- Chapter 5 : Conclusion —Social Issues and Goals in the Construction Industry—



https://www.obayashi.co.jp/woodvision/pdf/circular-timber-construction_report_eng_ver.pdf