ASSESSMENT OF STATE AGENCY PROCURMENT PROTOCOLS RELATED TO INNOVATIVE WOOD PRODUCTS

Prepared for:

Prepared by:

January 22, 2025
Final Report

TABLE OF CONTENTS

EXECUTIVE SUMMARY 6

BACKGROUND 7

PRODUCTS CONSIDERED IN THIS REPORT 8

Mass Timber 8
Wood Wool and Wood Fiber Cement Panels 8
Biochar 9
Biochar- and CNC-Infused Cement and Biochar-Infused Asphalt 9
Wood Fiber Insulation 10

SECTION 1: STATE POLICIES AFFECTING MATERIAL PROCUREMENT 10

State of California Initiatives and Policies 10
Executive Orders *11*
Legislation *13*
Regulations *13*
State Agency Sustainability Roadmaps *15*
California Procurement Policy Findings 16

GLOBAL SUPPORT FOR INNOVATIVE WOOD PRODUCTS 17

SUPPORT FOR INNOVATIVE WOOD PRODUCTS IN OREGON, WASHINGTON AND BRITISH COLUMBIA 17

Oregon 18
Washington 18
British Columbia 19
Summary of Policies in Support of Mass Timber: California, Oregon, Washington and British Columbia 19
Federal Policies Supporting Innovative Wood Products 20
Support for Innovative Wood Products in California Cities and Counties 21

INNOVATIVE WOOD PRODUCT EXAMPLES 22

Mass Timber 22
Biochar 24
CNC- and Biochar-Infused Cement 26
Wood Wool Cement Panels 27
Wood Fiber Cement Panels 28
Wood Fiber Insulation 28
Biochar-Infused Asphalt 28
Summary of Innovative Wood Product Examples 28

INNOVATIVE WOOD PRODUCT CARBON CREDIT CERTIFICATION 29

Climate Action Reserve 29
Verra 29
Aureus Earth 30
Puro Earth 30
Organizations that Broker Carbon Credits 30

SECTION 2: STATE AGENCY OUTREACH **31**

AGENCIES MANAGING CONSTRUCTION AND MAINTENANCE **32**

California Department of General Services *32*
California Department of Transportation *34*
California Department of Forestry and Fire Protection *35*
AGENCIES ADMINISTERING GRANT AND LOAN PROGRAMS 36
California Strategic Growth Council *36*
California Energy Commission *36*
AGENCIES REGULATING CONSTRUCTION 37
California Building Standards Commission *37*
Department of General Services – Division of the State Architect *38*
Office of State Fire Marshal *39*
California Air Resources Board *39*
SUMMARY OF AGENCY PROCUREMENT PROCEDURES 41

SECTION 3: OUTREACH TO VENDORS AND DESIGNERS **41**

VENDOR OUTREACH 42
Emerging Producers *44*
DESIGNERS AND BUILDER OUTREACH 44
PROJECTS IN CALIFORNIA 45
Mass Timber *45*
Wood Wool and Wood Fiber Cement Panels *47*
OTHER INNOVATIVE WOOD PRODUCTS 47
DESIGNERS AND BUILDERS IN CALIFORNIA 48
OBSTACLES TO DOING BUSINESS IN CALIFORNIA 49
Cost of Innovative Wood Products *49*
Review and Approval Process *49*
State Agency Selection Process *50*

SECTION 4: RECOMMENDATIONS AND IMPLEMENTATION **51**

JOINT INSTITUTE RECOMMENDATIONS TO EXPAND WOOD AND BIOMASS UTILIZATION IN CALIFORNIA **53**

ATTRACT INNOVATIVE WOOD PRODUCT PRODUCERS TO THE STATE 53
ENCOURAGE ADOPTION OF INNOVATIVE WOOD PRODUCTS BY STATE AGENCIES 54

SECTION 5: PROCESS FOR INCORPORATING CONSIDERATION OF INNOVATIVE WOOD PRODUCTS IN STATE PURCHASING **54**

RECOMMENDED PROCESS **55**

ROLE OF LCAS 55
MATERIAL AVAILABILITY 56
AVAILABILITY OF DESIGN AND CONSTRUCTION EXPERTISE 56
FINAL SELECTION 57

IMPLEMENTATION PROCESS AND TIMEFRAME **57**

CONCLUSIONS **57**

LIST OF TABLES

Table 1. Mass Timber Policy Comparison for Key States and British Columbia 20
Table 2. IWP Vendors Contacted.....43
Table 3. Mass Timber Designers and Builders Contacted.....45
Table 4. Environmental Impacts of Metal and Concrete Construction Compared to Wood 51

LIST OF FIGURES

Figure 1. Sacred Heart School, Atherton 23
Figure 2. San Mateo County Administration Building 24
Figure 3. Sonrisa Building 24
Figure 4. Wakefield Biochar 25
Figure 5. CNC- and Biochar-Infused Concrete Beams.....26
Figure 6. Wood Wool Cement Sound Wall 27

LIST OF APPENDICES

Appendix A. Key Contacts and Website List
Appendix B. Board of Forestry Letter of Introduction

LIST OF ABBREVIATIONS

Agencies

CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CAEATFA	California Alternative Energy and Advanced Transportation Financing Authority
CARB	California Air Resources Board
CBSC	California Building Standards Commission
CDCR	California Department of Corrections and Rehabilitation
CEC	California Energy Commission
DGS	California Department of General Services
DSA	Division of the State Architect
FW	Fabric Workshop
GO-Biz	Governor's Office of Business and Economic Development
HCD	California Department of Housing and Community Development
Joint Institute	Joint Institute for Wood Products Innovation
LCI	Governor's Office of Land Use and Climate Innovation
OSFM	Office of the State Fire Marshal
SGC	California Strategic Growth Council

Other Terms

AHSU	Affordable Housing and Sustainable Communities Program
AIA	American Institute of Architects
BUILD	Building Initiative for Low Emissions Development
CalGreen	California Green Building Code
CBC	California Building Standards Code
CNC	Cellulose Nanocrystals

CLT	Cross Laminated Timber
CMU	Concrete Masonry Unit
EO	Executive Order
EPD	Environmental Product Declaration
EQIP	Environmental Quality Improvement Program
FW	Fabric Workshop
GHG	Greenhouse Gas
IBC	International Building Code
IBI	International Biochar Initiative
ICC	International Code Council
IWP	Innovative Wood Product
LCA	Life Cycle Assessment
NMTC	New Market Tax Credits
TSS	TSS Consultants

EXECUTIVE SUMMARY

Increased utilization of innovative wood products (IWPs) by California State agencies has the potential to help the State meet its greenhouse gas (GHG) reduction and embodied carbon[1] goals, while increasing the pace and scale of forest management and restoration efforts within the State. TSS Consultants was retained by the Joint Institute for Wood Products Innovation (Joint Institute) to investigate current procurement protocols employed by State agencies. At the present time, there are no State agency purchasing procedures that encourage consideration of IWPs for State projects. This investigation found:

- Few State projects have included use of IWPs. To date, the main product used has been mass timber for building construction and renovation.
- State designers and managers at the Department of General Services (DGS), including the Division of the State Architect (DSA), are not well informed about the potential benefits of IWPs.
- Certain provisions of the State's building code create supply chain obstacles and design challenges for use of mass timber in State construction projects.
- Some IWPs are market ready and widely used in the private sector while others have not been accepted for use in State projects.

There are no producers of IWPs operating at a commercial scale within the State. Despite lack of local producers, California's private sector has adopted the use of IWPs (primarily mass timber) for hundreds of construction projects. Changes to the building code allowing mass timber to be used for multi-story buildings have fostered that growth.

If IWPs could be manufactured at scale within California, sourcing sustainably available raw materials from forest management and restoration projects, there would be economic and environmental benefits of far-reaching consequence. In addition, IWPs would be more cost competitive and even more climate-friendly due to reduced transportation distances.

In 2020 the Joint Institute adopted many recommendations that encourage use of IWPs.[2] Building upon that foundation, additional recommendations generated from this 2024 investigation include:

1. **State agency designers and decision makers** at all agencies involved with procurement should account for the carbon benefits of IWPs in their procurement decisions to be consistent with policies advocating reduced embodied carbon in buildings and net zero GHG emissions in the future.

2. **CAL FIRE and Caltrans** should support continued research into IWPs through policy and financial incentives.

[1] https://www.epa.gov/greenerproducts/what-embodied-carbon Embodied carbon—also known as embodied greenhouse gas (GHG) emissions—refers to the amount of GHG emissions associated with upstream—extraction, production, transport, and manufacturing—stages of a product's life. Many initiatives to track, disclose, and reduce embodied carbon emissions also consider emissions associated with the use of a product and its disposal.

[2] https://bof.fire.ca.gov/media/31nfixsv/final-board-approved-joint-institute-wood-and-biomass-utilization-recommendations-_11-4-20_ada.pdf

3. **State agency designers and decision makers** should be required to become better informed about the benefits and uses and IWPs through continuing education offerings by the Wood Institute, WoodWorks, American Institute of Architects (AIA) Los Angeles, the U.S. Green Building Council, the American Society of Civil Engineers, or other professionally recognized organizations.

4. **SGC, CEC, and HCD** should consider the use of IWPs in projects funded by their competitive grant programs. This should also apply to housing designed pursuant to Executive Order N-06-19.

5. **CBSC** should modify provisions of the CBC that impair use of IWPs in State projects, specifically the requirement for continuous monitoring for CLT and glulam production for DSA and Office of Statewide Health Planning and Development projects as well as other restrictions requiring height and area limitations applicable to mass timber buildings. Consideration should also be given to addressing restrictions regarding use of other IWPs, such as wood fiber insulation.

6. **The Joint Institute** should spearhead an effort to create a collaborative of State and federal agencies, educational and research institutions, and the private sector that will work to further the understanding and use of IWPs in both the public and private sectors. This collaborative should strive to establish information sharing procedures with agencies in other states and internationally, as appropriate.

7. **GO-Biz and LCI** should provide financial and regulatory incentives for the establishment of IWP manufacturers in California that will source raw material from California forest management and restoration projects.

8. **The Joint Institute** should create a staff position dedicated to monitoring State agency trends regarding procurement of IWPs for State projects. Policies and procedures should be evaluated in status reports prepared by the Joint Institute at five-year-intervals.

9. **The Governor** should issue an Executive Order (EO) implementing these recommendations.

BACKGROUND

TSS Consultants (TSS) was retained by the Joint Institute to investigate State policies and procedures related to procurement of IWPs for State construction and maintenance projects. The study has three components: review of published State policies and procurement protocols, outreach to State agency personnel involved with the design and implementation of construction and maintenance projects, and outreach to vendors of IWPs and private sector designers, engineers, and builders that utilize these products in their projects. This report is a compendium of those three components along with recommendations to phase IWPs into State procurement procedures over a two-year implementation period. To the degree that IWP source materials are derived from California forests in the future (that is not currently the case), their use will support the State's goals for increased landscape-scale forest restoration and resilience activities.

PRODUCTS CONSIDERED IN THIS REPORT

There are several IWPs that have emerged in the marketplace over the past few decades. Some of these have an extensive track record in Europe, Canada, other States, and in California's private sector, while others are still experimental or currently have very limited deployment. The following is a description of the wood products considered in this investigation, their current uses in California, and the potential for utilizing them in State agency-sponsored construction, maintenance, and other projects.

Mass Timber

Mass timber refers to fabricated structural elements such as cross laminated timber (CLT), including glue, nail, and doweled panels, beams, and posts. It also includes mass plywood comprised of dimensional boards. In the Pacific Northwest, most mass timber is composed of spruce, Douglas-fir, cedar, and pine. Mass timber construction projects in California include residential, commercial, and public buildings. Given State policy regarding embodied carbon and reduced GHG emissions considered on a life cycle basis, there is great potential for use of mass timber as a substitute for more carbon-intensive building materials in State building construction projects, other public sector construction projects subject to review and approval by State agencies, and private sector construction projects subject to State oversight or funding. Potential for wider use of mass timber is especially promising given changes to the CBC made permanent in 2021 permitting wood structures up to 18 stories.[3] Studies have indicated that substituting mass timber for steel and concrete in mid-rise buildings (5-10 stories) can reduce emissions associated with manufacturing, transporting, and installing building materials by 13-26 percent.[4] With the exception of potential operations in Humboldt (Schmidbauer Group) and Shasta (Fabric Workshop) Counties, there are currently no producers of mass timber structural elements active in California.

Wood Wool and Wood Fiber Cement Panels

Wood wool and wood fiber cement panels have applications in conventional building construction and specialty projects such as acoustically certified facilities. Both softwood and hardwood timber species are used to manufacture these products. Wood wool cement sound walls, shooting ranges, and entertainment studios have been built in California at a modest scale by federal agencies, county sheriff departments, and sports/entertainment venues. Wood fiber cement panels are used extensively for exterior cladding in private sector residential, commercial, and industrial construction. Although ordinary Portland cement has a high level of embodied carbon, incorporation of wood wool or wood fiber into fabricated panels results in less net embodied carbon in the panel. There is modest potential for using these products in State building construction projects, other public sector construction projects subject to review and approval by State agencies, and private sector construction projects subject to State oversight. Wood wool cement panels are not manufactured in California.[5]

[3] https://www.dgs.ca.gov/BSC/Resources/2022-Title-24-California-Code-Changes/Tall-Wood-Mass-Timber
[4] https://www.fpl.fs.usda.gov/documnts/pdf2022/fpl_2022_pasternack001.pdf
[5] However, James Hardie has a wood fiber cement panel manufacturing facility in Fontana, CA.

Biochar

Biochar is produced through heating biomass, in the total or partial absence of oxygen. Biomass sources include wood waste, agricultural waste, biosolids, and manure. Biochar has many applications in landscaping (soil amendment and water retention), stormwater filtration, as additives to cement and concrete, solid waste treatment, and decontamination of hazardous wastes. As a soil amendment, it sequesters carbon in a stable, long-term form. Production of biomass from residues produced from forest management activities can offset emissions from activities such as pile burning.[6] Biochar has been widely accepted in Europe and at least one State (Washington) for uses such as soil amendment and stormwater filtration. As a soil amendment it is commercially available in limited quantities at gardening stores in California. Globally its production increased three-fold between 2021 and 2023.[7] As of 2021, there were 15 producers of biochar in California, but none were producing large quantities.[8] The U.S. Biochar Initiative website currently (2024) lists 10 biochar producers in California.[9] Biochar has some potential (currently limited due to lack of supply) for use by State agencies.

Biochar- and CNC-Infused Cement and Biochar-Infused Asphalt

Biochar- and CNC-infused cement, biochar-infused asphalt, and variants utilizing additives such as biomass power plant fly ash have not been widely adopted by the private or public sectors as a replacement for conventional products in road and bridge construction or maintenance projects. One CNC concrete bridge project was successfully constructed in Yreka, California as a proof of concept.[10] Initial findings from biochar-infused asphalt research (sponsored by U.C. Davis, Arizona State University, and Caltrans) confirm that biochar-infused asphalt has longer wear and produces fewer emissions (e.g., reduced volatile organic compounds) over its service life.[11] U.C. Davis is investigating the performance of several different cellulosic materials combined in cement (see Section 3 of this report). Caltrans refers to cement with additives such as biochar and CNCs as "supplemental cementitious materials." Additives may include fly ash and bottom ash produced from combustion in biomass energy plants as well as biochar and CNCs. Studies sponsored by the Joint Institute and conducted by researchers at Oregon State University found that CNC-infused ordinary Portland limestone cement has 19 percent lower GHG emissions than conventional cement.[12] [13] The addition of CNCs to the ordinary Portland limestone cement was found to not compromise the structural integrity nor the service life of the steel in the concrete.

[6] https://bof.fire.ca.gov/media/kdunxevi/demo-handout-1-biochar-in-the-woods-using-portable-flame-cap-kilns_doi-10-379165543.pdf
[7] https://biochar-international.org/2023-global-biochar-market-report/
[8] https://www.researchgate.net/figure/List-of-active-biochar-producers-in-California_tbl1_353939753
[9] https://biochar-us.org/directory
[10] https://research.fs.usda.gov/fpl/news/featured/nanocellulose-and-concrete-happy-marriage
[11] https://pubs.acs.org/doi/10.1021/acssuschemeng.2c06292 and https://www.tandfonline.com/doi/abs/10.1080/14680629.2021.2012238
[12] https://bof.fire.ca.gov/media/4najhupx/3-8-23-bof-cnc-carbon-reduction-in-cement-final-report_ada.pdf
[13] https://bof.fire.ca.gov/media/prmp4rs1/measuring-transport-properties-for-concrete-containing-cellulose-nanocrystals.pdf

Wood Fiber Insulation

There is one producer of wood fiber insulation in the U.S., (TimberHP) located in Maine.[14] They produce loose fill, batts, and boards that can be used as substitutes for conventional insulation made from non-renewable materials such as fiberglass and petroleum-based foam with high levels of embodied carbon. Eastern white pine is utilized by TimberHP as the primary feedstock. The top installation contractors are in Kansas, Missouri, and Nebraska, and there is an outlet for TimberHP products in Reno, Nevada.[15] Wood fiber insulation has potential for use in State building construction projects, other public sector construction projects subject to review and approval by State agencies, and private sector construction projects subject to State oversight or funding. Its use may be limited due to constraints on use of combustible materials in certain construction types, potentially including State buildings.[16]

SECTION 1: STATE POLICIES AFFECTING MATERIAL PROCUREMENT

This section describes the results of efforts to obtain and review current policy and purchasing protocols of California State agencies, as well as those of Oregon, Washington, and British Columbia. The objective was to determine to what extent they recognize and support the market growth of forest-derived IWPs by their respective governmental agencies. Through these policies and protocols, governments may seek to achieve economic and environmental goals such as improvement of forest health and resiliency, support of forest industries and reduction of GHG emissions associated with construction and maintenance projects.

Oregon, Washington, and British Columbia have implemented initiatives, programs, and legislation to encourage use of IWPs (particularly mass timber), but they have not adopted purchasing protocols to require their use. California is also supporting IWPs through the adoption of several key policies and programs that could directly or indirectly encourage their use in agency-funded construction and maintenance activities. These include EOs and legislation as well as other mandates such as meeting "sustainability guidelines." Although there are many proclamations and directives regarding reducing California's carbon footprint, the State lacks purchasing guidelines pertaining to IWPs, when appropriate, to help the State meet its forest health, climate, and embodied carbon objectives. This is the situation despite mounting evidence that IWPs are superior alternatives to comparable construction and maintenance materials in terms of embodied carbon and GHG emissions.

State of California Initiatives and Policies

Policy support for deployment of IWPs within California ranges from EOs, issued by Governors Brown and Newsom, to legislative mandates. This section of the report assesses those policies. The last part of this section provides succinct descriptions of IWP examples with an emphasis on California. In some cases, California agencies are currently experimenting with the use of IWPs, and those efforts are described.

[14] https://www.timberhp.com/
[15] https://www.timberhp.com/find-a-distributor
[16] Lisa Podesto, Director of Mass timber and Construction Innovation, Swinerton, Personal Communication, June 22, 2024.

Executive Orders

There are four key EOs that relate to State goals to reduce GHG associated with construction and maintenance projects. Two other EOs could encourage consideration of IWP use by State agencies.

Executive Order B-18-12

Issued by Governor Brown on April 25, 2012, EO B-18-12[17] is considered a foundation for the State's focus on sustainability. This EO mandates that all new State buildings and major renovations be net zero energy facilities by 2025. The order mainly applies to energy consumption, grid-based energy purchases, and water conservation. It does refer to the purchase and use of environmentally preferable products that have a reduced effect on human health and the environment when compared to competing goods, but it does not provide examples (see following discussion on environmentally preferable purchasing in this section). This EO does not address construction materials.

Executive Order B-30-15

Issued by Governor Brown on April 29, 2015, EO B-30-15[18] established the Statewide GHG emissions target of 40 percent below 1990 levels by 2030 and 80 percent by 2050. It requires State agencies to develop plans and programs to meet those targets. It also advises agencies to take climate change into account when making planning and investment decisions.

Executive Order B-52-18

Issued by Governor Brown on May 10, 2018, EO B-52-18[19] established the Joint Institute. It also required that the Office of the State Fire Marshal (OSFM), HCD, DSA, CBSC, and the Office of Statewide Health Planning and Development review the approved Tall Wood Building Proposal of the International Code Council's (ICC) Ad Hoc Committee on Tall Wood Buildings and consider proposing the adoption of the Tall Wood Buildings Proposal into the CBC. Lastly, it directed DGS, in collaboration with other State agencies, to identify three building projects in which to utilize manufactured wood products as both structural and aesthetic components.

The requirement for agency review of the 2021 ICC model code changes to allow mass timber buildings up to 18 stories in height for inclusion in the 2019 CBC and Intervening Code Adoption Cycle resulted in ratified amendments issued as a supplement with a July 1, 2021, effective date. These Tall Wood building provisions were modified by the OSFM to be consistent with OSFM restrictions applied to other traditional construction types. This was a point of debate during the Intervening Code Adoption Cycle, but due to time constraints it could not be addressed. These provisions and modifications are now included in the current (2022) CBC.

The mandate to identify three State building projects in which to utilize mass timber was not implemented. However, in 2020, the Governor's Forest Management Task Force and LCI sponsored a "Mass Timber Design Competition" that awarded $500,000 in prizes to four design firms.[20] The four projects that were selected included three that have been built in San Francisco

[17] https//www.green.ca/gov/buildings/resources/executive order/
[18] https//www.library.ca.gov/wp-content/uploads/GovernmentPublications/executive-order-proclamation/39-B-15-pdf
[19] Archive.gov.ca.gov/archive/gov39/wp-content/uploads/2018/05/5.10.18-Forest-EO.pdf

[20] https://resources.ca.gov/Newsroom/Page-Content/News-List/California-Promotes-Architectural-Innovation-Through-Mass-Timber-Competition

and Orange County. In addition, one honorable mention project has been built in Sunnyvale. None of the projects are State buildings. The design competition was administered by WoodWorks.[21]

Executive Order B-55-18

Issued by Governor Brown on September 10, 2018, EO B-55-18[22] set a State goal of achieving carbon neutrality by 2045 and maintaining net negative GHG emissions thereafter. Construction or maintenance projects were not addressed.

Other than the requirement for engaging in CBC revisions affecting mass timber and the mass timber design competition, note that none of these EOs directly suggest incorporating forest products (including IWPs) into State programs as a means of achieving carbon neutrality. For example, the Green Building Action Plan that implements EO B-18-12, makes no reference to forest products.[23]

Executive Order N-04-19

Issued by Governor Newsom on January 8, 2019, EO N-04-19[24] proposed an alternative approach to State procurement based on "Requests for Innovative Ideas" for solving specific problems. Agencies can develop an "Innovation Procurement Sprint" asking academics and the private sector to propose solutions. A phased process will be used to evaluate alternative solutions and, if appropriate, negotiations to provide prototypes and/or implement demonstrations may be conducted. Innovators may be compensated for their efforts. This EO states that the first Innovation Procurement Sprint will be executed to identify innovative solutions to the State's wildfire crisis. There is no reported status of that offering. The current Innovation Procurement Sprint has been issued by DGS and pertains to innovative ideas for an over-the-counter antigen test.

Executive Order N-06-19

Issued by Governor Newsom on January 15, 2019, EO N-06-19[25] directed DGS to create a digitized inventory of State-owned properties that are deemed surplus to agency needs. DGS was also charged with the responsibility for developing screening tools to prioritize locations where affordable housing projects are likely to be economically feasible. Using those tools, DGS produced a map of excess State properties that are suitable for affordable housing projects.[26] DGS has been working with HCD to request proposals from developers for constructing housing projects. Proposals should consider the use of "renewable construction materials, such as cross-laminated timber." Although the obvious focus of this order, and the process established by it, is on affordable housing, when viewed in conjunction with other EOs and AB 2446 (discussed below), it may encourage increased use of IWPs.

Sonrisa studio apartments[27] is the first project constructed under the mandate of EO-N-06-19. It is a five-story mixed use building with 58 studio apartment residential units. It was built with CLT on a concrete slab foundation, and it was the first of its kind in Sacramento. It is perhaps the precursor of additional future affordable housing projects utilizing IWPs. The choice of mass timber as the

[21] https://www.woodworks.org/
[22] archive.gov.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Execitoive-Order.pdf
[23] Archive.gov.ca.gov/archive/gov39/wp-content/uploads/2017/09/Green_Building_Action_Plan_B.18.12.pdf
[24] gov.ca/wp-content/uploads/2019/01/1.8-EO-N-04-19.pdf
[25] Gov.ca.gov/wp-content/uploads/2019/01/EO-N-06-19.pdf
[26] https://cadgs.maps.arcgis.com/apps/webappviewer/index.html?id=392e5e687e9041bb8f20e3acc5b211c7
[27] https://www.sonrisadowntown.com/sustainability

construction material may have been made in response to previous statements of support for its use by the OSFM, CBSC, DSA, and HCD when tall wood/mass timber amendments were made to the CBC.

Legislation

The legislation that is most relevant to the potential use of IWPs in helping to meet ambitious GHG emissions and carbon goals is Assembly Bill 2446, signed by Governor Newsom in September 2022.[28] It seeks to achieve a 40 percent reduction in new building GHG emissions by 2035. It requires creating a framework for measuring and reducing the average carbon intensity, i.e., "embodied carbon emissions," of residential projects of five or more units as well as non-residential construction of 10,000 square feet or more. It directed the California Air Resources Board (CARB) to create that framework. AB 2446 furthermore advocated the evaluation of measures to support market demand and financial incentives to encourage production and uses of materials with low GHG intensity. Section 38561.3 of the bill requires that manufacturers of building materials must provide an "Environmental Product Declaration" (EPD) based on a robust life cycle assessment (LCA). In comparing the use of mass timber versus steel and concrete for a portion of a construction project, the embodied carbon of each would be estimated over their respective life cycle. Feasibility of using the superior material would be based on its availability in the region. In cases of significant cost differences, exemptions from the requirement to use the superior product may be granted.

Assembly Bill 262, known as "Buy Clean California Act" was signed by Governor Brown in October 2018. It required that several construction materials (structural steel, concrete reinforcing steel, flat glass, and mineral board insulation) meet mandated maximum "Global Warming Potential" limits.[29] These limits are analogous to embodied carbon and are estimated over a 100-year timeframe. Note that these provisions are codified as Public Contract Code Section 3500-3505.[30] Although not directly relevant to wood products, the limits set for these alternative construction materials might support the use of alternative materials such as IWPs.

Regulations

On June 30, 2022, the CBSC, DSA, and HCD convened a CalGreen Carbon Reduction Collaborative to provide input and feedback for future carbon reduction regulations to be included in the 2022 California Green Buildings Code. The results of that effort were changes to the California Green Buildings Standards Code Part 11, Title 24, California Code of Regulations that became effective on January 1, 2023. The changes include regulations for energy efficiency, water efficiency and conservation, material conservation, and resource efficiency. There are both mandatory and voluntary provisions.

The CalGreen Carbon Reduction Collaborative is continuing work on embodied carbon, whole building LCA, and net zero carbon design. The California American Institute of Architects, a founding member of the collaborative, has successfully instituted a continuing education requirement for California's licensed architects in designing buildings that minimize GHG

[28] https://legiscan.com/CA/text/AB2446/id/2607014
[29] https://legiscan.com/CA/text/AB262/id/2784420
[30] https://up.codes/viewer/california/ca-green-code-2022/chapter/2/definitions#buy_clean_california_act

emissions. The Collaborative is focusing on a limited number of materials where there has already been significant research and development, such as concrete, which is a key component of every building.

Based on the work of the CalGreen Carbon Reduction Collaborative, in early August 2023, California adopted mandatory measures that will limit embodied carbon in commercial and school buildings.[31] California is the first State in the nation to adopt these requirements. Embodied carbon encapsulates the carbon emissions from the entire lifespan of a building, including materials sourcing, manufacturing, construction, maintenance, and eventual demolition. The new regulation limits embodied carbon for commercial buildings larger than 100,000 square feet and school buildings larger than 50,000 square feet by one of three pathways, including a performance path using LCA, a prescriptive path using EPDs, or another alternative such as building reuse. The embodied carbon accounted for in EPDs includes GHG emitted from cradle to grave (during material sourcing and manufacturing), while LCAs go beyond this and include emissions from construction, maintenance, and eventual demolition. Emphasizing wood products including IWPs in buildings represents a potential approach to meeting mandatory requirements for reduced embodied carbon.

As previously noted, as mandated by AB 2446, CARB is charged with the responsibility of developing a regulatory framework for measuring and reducing the average carbon intensity of materials used in the construction of new buildings and to develop a comprehensive strategy to reduce embodied carbon in buildings.[32] The current status of that effort is discussed in the following section of this report on State Agency Outreach.

In 2021 the International Building Code (IBC) added important changes in material technologies and their expanded use with "tall wood buildings," which use mass timber as structural elements. However, the 2021 IBC would not have become effective in the CBC (Title 24 of the California Code of Regulations) until January 1, 2023, unless cooperative agency action was taken. Acknowledging the need to accelerate the inclusion of these technologies, several State agencies (OSFM, CBSC, DSA, and HCD) proposed for adoption tall wood/mass timber building standards for early use. On November 5, 2020, the CBSC voted to include the new standards in the 2019 CBC as an "Intervening Code Supplement." This was published on December 31, 2020, with an effective date of July 1, 2021. Taking this action clearly demonstrates the State's interest in promoting mass timber, as exhibited in the recently constructed Sonrisa Project (described below). As a result of this action, projects such as the two 18-story mass timber buildings in Oakland (1510 Webster Street and 1523 Harrison Street) became feasible. Advocates of mass timber have suggested that support needs to continue with more recent updates in the 2024 IBC so that mass timber-related provisions make their way into the 2022 CBC in an intervening cycle instead of waiting until 2025 when the next iteration of the CBC gets released.

Although legislative mandates might be interpreted to support the use of other IWPs such as biochar and wood wool cement, there are no specific references to these as alternatives to more carbon-intensive materials in these edicts.

[31] https://www.dgs.ca.gov/BSC/CALGreen
[32] https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-program/

State Agency Sustainability Roadmaps

In response to EOs and the sustainability goals of Governors Brown and Newsom, the DGS Office of Sustainability developed a "Sustainable Policy and Best Practices Manual."[33] This document, in turn, was used by that department and other State agencies to produce "Department Sustainability Roadmaps."[34] The most relevant sections of these documents pertain to "Environmentally Preferable Purchasing" defined as follows (PCC section 12400):

"Environmentally preferable purchasing considers measures that reduce impacts on human health and the environment resulting in less embodied energy, energy and water use, reduced waste, less material used, durability and many factors. It includes looking at the life cycle of products to assess their impacts over and after the products' life cycles. It means the procurement or acquisition of goods and services that have a lesser or reduced effect on human health or the environment when compared with competing goods or services that serve the same purpose. The comparison shall take into consideration, to the extent feasible, raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, disposal, energy efficiency, product performance, durability, safety, the needs of the purchaser, and cost."

DGS monitors purchases of environmentally preferable products through the State's fiscal purchasing program. The DGS "Buying Green Guide"[35] that provides guidance on this does not address construction materials.

Although all the department sustainability roadmaps and the DGS best practices manual contain a section on environmentally preferable purchasing, none of them directly address the potential role of wood products, including IWPs that perform the same functions as materials that are more carbon intensive. They primarily refer to purchases of commodities used for operations with an emphasis on recycled materials.

The sustainability roadmaps prepared by CARB, Caltrans, CAL FIRE, and the California Department of Corrections and Rehabilitation (CDCR) were reviewed to ascertain if there were any references to IWPs in sections other than environmentally preferable purchasing. The template for the roadmaps is the same for all agencies. There are sections on adaptation to climate change, zero emissions vehicles, energy, water efficiency and conservation, and green operations. The CARB roadmap refers to the construction of a new Southern California headquarters. It states that:

"Life cycle considerations are given to all building elements, including the structure itself, foundations and footings, materials, equipment, and finishes. Operations and maintenance considerations are included in the design and selection of materials, equipment, and functions of these items."

There is no indication that the potential use of IWPs such as mass timber, wood fiber cement panels, or cement infused with biochar or CNCs to offset GHG emissions was considered.

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[33] https://www.dgs.ca.gov › Policies › CASPBPM

[34] https://green.ca.gov/home/roadmaps

[35] https://www.dgs.ca.gov/PD/Resources/Find-EPP-Goods-and-Services

The roadmap for CDCR refers to design and construction policy guidelines that outline requirements to consider and mitigate GHG emissions. However, it states that:

"The nature of CDCR's operations dictates the need for very sturdy shell construction (i.e., concrete, concrete block, metal framing, and structural steel) that has a typically longer lifecycle than other types of construction (i.e., wood framing, etc.)."

Although there is no evidence to support the supposition that concrete projects, etc., necessarily have longer life cycles than wood, this would seem to limit the likelihood that the agency would consider mass timber for its construction or renovation projects. However, it does not eliminate the potential for using wood wool cement panels or cement infused with biochar or CNCs.

The Caltrans roadmap states that its construction standard specifications include guidance on the composition of materials to be used in construction projects. These specifications require Caltrans to consider environmentally friendly treatments and materials with recycled content to the extent feasible. There is no evidence that Caltrans has employed IWPs such as mass timber, CNC-infused cement, wood wool cement panels (e.g., sound walls) or biochar (e.g., as a soil amendment) in its construction or maintenance projects. Caltrans has instituted two research projects on the potential use of biochar alone, or in combination with other materials, as a means of filtering pollutants from stormwater.[36] It has also provided funding to Oregon State University, Arizona State University, and U.C. Davis to conduct research on alternative paving materials such as biochar-infused asphalt to evaluate the feasibility and technical merits of its use. The objective is to determine if its use results in reduction of volatile organic compounds and delays aging of roadways. Funding from the U.S. Forest Service-sponsored Wood Innovations Grant program is also supporting this research.

The CAL FIRE roadmap predicts replacement of two percent of its facilities or 10 projects per year over the next five years, subject to budgetary constraints. The roadmap states:

"CAL FIRE actively promotes and conducts research on innovative new wood products (such as mass timber) … in the face of an uncertain climate future. "

It reiterates the statement by CARB that lifecycle considerations are given to all building elements. It fails to state that IWPs will be considered in its future building plans.

California Procurement Policy Findings

In summary, there is an apparent vacuum in State procedures for environmentally preferable purchasing regarding the role of IWPs in meeting the State's objectives for reduced embodied carbon and GHG emissions. This vacuum exists despite the advocacy of CAL FIRE for use of these products as demonstrated by the existence of the Board of Forestry and Fire Protection's Joint Institute. Actions by State agencies to revise the CBC also are indicative of support for mass timber. When CARB produces guidelines for implementing AB 2446 there may be a stronger mandate. Also, EO N-06-19 in combination with other EOs and AB 2446 may create a demand for using IWPs in sponsored affordable housing projects. This is of particular interest since it is a major focus of the Oregon Mass Timber Coalition, discussed below.

[36] Interview with Greg Stangl, Phoenix Energy. Forest-based biochar used as storm water filtration medium Q4 2019 at Carquinez bridge and the I-680/80 interchange in Cordelia.

GLOBAL SUPPORT FOR INNOVATIVE WOOD PRODUCTS

Other nations have provided support for the use of IWPs. As of 2022, Europe was home to 60 of the 84 tallest mass timber projects in the world.[37] In 2022, Congress initiated a survey of mass timber policies in 33 countries where relevant legislation and policies exist.[38] Several countries, including Austria, Canada, Switzerland, Japan, and Croatia actively promote the use of wood and mass timber in construction projects. For example, Austria promotes the use of wood as an "active contribution to climate protection." Croatia requires that all public buildings include at least 30 percent wood.

Other countries included in the study commissioned by Congress do not have "wood first" legislation or policies but promote the use of mass timber and wood in other ways. For example, Sweden established a fund to promote the use of wood in construction, particularly multi-family housing. Finland set a goal of using wood in 45 percent of its public buildings by 2045.

A few countries have modified building codes or other regulations to allow for the use of mass timber in construction. In Canada, the National Building Code now allows for use of mass timber in buildings up to 12 stories. There are European Union regulations applicable to member nations that address positive performance characteristics of mass timber. In 2017, the United Kingdom revised its restrictions on use of combustible building materials in tall buildings, but specifically indicated that those should not limit innovation in the use of CLT. Other countries have set up informational websites on the use of mass timber

There is also significant support for the use of biochar in Europe. There are 72 European processors producing about 80,000 tons/year.[39] There is a very active group of "certifiers" that quantify and provide carbon offset credits to biochar producers in Europe. The European biochar market was worth 0.76 billion U.S. dollars in 2022 and is projected to be worth 1.63 billion dollars by 2028.[40]

Europe is also home to producers of wood wool cement panels who source their fiber as a byproduct of lumber production. Troy Acoustics, a designer and builder of wood wool cement structures (headquartered in Brunswick, Georgia) imports its wood wool cement panels from Europe.[41] No European countries appear to have specific policies concerning IWPs other than mass timber and biochar.

SUPPORT FOR INNOVATIVE WOOD PRODUCTS IN OREGON, WASHINGTON AND BRITISH COLUMBIA

Below is a brief description of State and Provincial support for mass timber in Oregon, Washington, and British Columbia. Except for support for use of biochar in public works projects in Washington (described below) and research on biochar at universities, a cursory review did not disclose governmental support for other IWPs in Oregon, Washington, or British Columbia. It should be noted, however, that Colorado recently passed the "Buy Clean Colorado Act" that requires their

[37] https://www.architecturalrecord.com/articles/16292
[38] https://sgp.fas.org/crs/misc/R47752.pdf 2022
[39] https://old.biochar-industry.com/wp-content/uploads/2021/02/Market-Overview_public_2021-02-17_V1.01.pdf
[40] https://www.marketdataforecast.com/market-reports/europe-biochar-market
[41] Bill Bergiadis, Troy Acoustics Inc., Personal Communication, October 23, 2023.

Office of the State Architect to establish maximum acceptable global warming potential limits for building materials including asphalt, cement and concrete, glass, steel, and wood.[42] The limits will not apply to the upkeep of roads, highways, or bridges. The focus is on the production phase of materials. Designers must include EPDs for the materials they plan to use in proposed projects. Those EPDs must be within the acceptable limits. The intent is to reduce the embodied carbon content of Colorado public projects and prioritize products with acceptable EPDs in designs. EPDs must be third-party verified. Transportation-related emissions for products sourced more than 100 miles from the project site must be submitted along with EPDs. Limits have been set for 2024 for all eligible materials except post-tension steel. It is uncertain whether the use of EPDs alone will encourage the use of wood and IWPs in construction projects. It may, however, increase awareness of the relatively favorable embodied carbon attributes of wood versus other materials.

Oregon

The Oregon Mass Timber Coalition is a partnership between the Oregon Department of Forestry, Oregon Department of Land Conservation and Development, University of Oregon, Oregon State University, Port of Portland, Business Oregon, and Tallwood Design Institute. Its mission is to promote the use of mass timber construction as a means of addressing the State's housing needs, supporting rural economies, improving forest health, and addressing climate change.[43] It is organized to respond quickly to funding opportunities and provide solutions to issues that cannot be resolved by individual entities alone. The Coalition's actions highlight the relationship between forest restoration activities on National Forest-managed forestland supplying timber to produce modular housing using mass timber. It is supported by a $41.4 million grant from the U.S. Economic Development Administration aimed at employment development, sustainable forestry, and mass timber housing. The Port of Portland has created a site for a facility that will build and supply mass timber panels that will be fabricated into modular housing that will be deployed to communities in need within Oregon. The governor of Oregon has a goal of creating 36,000 units of new housing each year. The Oregon legislature has committed $5 million towards the creation of a prototype housing manufacturing facility. Other projects supported by the Coalition include research on the acoustic, fire resistance, and structural performance of mass timber systems; development of workforce training locations; partnering with the Willamette National Forest to provide logs for mass timber manufacturing; and creation of model development codes to facilitate mass timber construction. Oregon was the first State to modify its building code to allow multi-story mass timber construction (in 2018).

Washington

In 2022 the Washington State Legislature passed a bill requiring the consideration of biochar for use in public works projects. The State Department of Ecology developed a guidance document addressing the use of high performance bioretention soil mixes including biochar for water quality management.[44] Washington passed a bill in 2018 requiring the development of building codes for the use of mass timber in residential and commercial building construction.[45] Subsequent changes to the building code allow mass timber structures as tall as 18 stories. As of July 2024, there were over

[42] https://osa.colorado.gov/energy-environment/buy-clean-colorado-act
[43] https://www.masstimbercoalition.org/
[44] https://apps.ecology.wa.gov/publications/documents/2110023.pdf
[45] https://app.leg.wa.gov/rcw/default.aspx?cite=19.27.570

180 mass timber structures built, under construction, or being designed in Washington.[46] For example, Founders Hall at the University of Washington is a six-story mass timber structure that was built to meet the University's "Green Building Standards."[47] It achieves a 76 percent reduction in cumulative carbon emissions and uses 70 percent less energy than a comparable facility built with conventional methods and materials. In 2019, the Washington Department of Revenue expanded the eligibility of timber activities for a preferential (lower) tax rate to mass timber product manufacturers.[48] This is a mechanism for incentivizing primary and secondary manufacturing within Washington as the industry continues to grow.

British Columbia

British Columbia decision makers have acknowledged that support for innovation through their policies will provide long-term benefits to their timber-dependent economy, especially in view of the growth of mass timber construction in the U.S. and abroad. The "Wood First Initiative" in British Columbia focuses on advancing wood use and innovative wood construction technologies in the province.[49] The "Wood First Strategy" emphasizes and provides funding for partnerships to promote innovation in manufacturing, building design, and construction with specific reference to taller mass timber and mass timber hybrid structures. Funding priorities for 2023-2024 include research and innovation, strengthening manufacturing and business capability, education and skills development and marketing, promotion, and outreach. The "Wood Works" initiative (similar to the U.S. WoodWorks) is funded in large part by the province. Their website[50] provides resources including design software, construction manuals, and an "e-learning" application for use by architects and builders. The Woodworks Innovation Network, hosted and funded by U.S. WoodWorks and Natural Resources Canada, is "a professional online community that provides resources for design and construction professionals looking to incorporate sustainable wood products into their projects."[51] It operates across Canada. As of 2023, the British Columbia building code allowed mass timber buildings up to 12 stories. Proposed changes for 2024 will increase the height limit to 18 stories.

Summary of Policies in Support of Mass Timber: California, Oregon, Washington and British Columbia

As noted above, there are no formal IWP procurement procedures currently used in California, Oregon, Washington, or British Columbia. However, there are State, and Province driven policies being implemented to support consideration of mass timber for government projects. Table 1 summarizes policies within these States and British Columbia regarding mass timber.

[46] https://www.woodworks.org/wp-content/uploads/WoodWorks-Mass-Timber-Projects-June-2023.png
[47] https://sustainability.uw.edu/campus/buildings/green-building-standards
[48] https://dor.wa.gov/sites/default/files/2022-02/sn_19_TimberActivitiesExpanded.pdf
[49] https://www.bcfii.ca/our-funding-programs/wood-first/
[50] https://wood-works.ca/bc/
[51] https://www.woodworksinnovationnetwork.org/en-ca/

Table 1. Mass Timber Policy Comparison for Key States and British Columbia

California	Washington	Oregon	British Columbia
Executive orders are supportive of reduced carbon emissions and use of "renewable construction materials, such as cross-laminated timber." Legislation supports reduced GHG emissions and embodied carbon in buildings. Building code permits mass timber buildings up to 18 stories in height.	Washington's building code allows construction of mass timber buildings up to 18 stories in height. Mass timber producers receive a preferential (lower) tax rate.	Oregon Mass Timber Coalition's mission promotes the use of mass timber as a means of addressing the state's housing needs. It is a partnership between the state, academic institutions, and the private sector. In 2018, Oregon was the first state to modify its building code to allow mass timber buildings.	The British Columbia "Wood First Initiative" focuses on advancing wood use and innovative wood construction technologies in the province. The building code allows mass timber buildings up to 12 stories in height. Proposed changes would allow construction up to 18 stories.

Oregon and Washington are the two largest producers of softwood lumber and plywood in the U.S. Wood products manufacturing is the most important industry in British Columbia. It is only reasonable to expect that these jurisdictions would place emphasis on the promotion of IWPs that will incidentally play an increasing role in the achievement of reduced GHG emissions in the future. Economic incentives are not the primary incentive in California where the forest industry sector is a relatively small contributor to the State's economic wellbeing. In the short term, if California's State agencies are to increase purchasing of IWPs, it will be driven by climate objectives, not economic objectives. However, if in the future, materials derived from forest management and restoration projects in California are used to produce IWPs in the State, there could be significant environmental and economic benefits.

It should be noted that educational institutions in all the States reviewed as well as agencies such as the Natural Resources Conservation Service, U.S. Army Corps of Engineers, and U.S. Forest Service have or support programs conducting research on IWPs, including mass timber, CNC-infused cement and asphalt, and biochar. If findings from these studies conclude that IWPs are superior to alternative materials, wider adoption by the public and private sectors would be expected.

Federal Policies Supporting Innovative Wood Products

Although not a primary focus of this investigation, it is of interest to note that there are at least three initiatives at the federal level that are supportive of IWP utilization. These are in addition to the strong financial and policy support that is provided by the U.S. Forest Service.[52] The first of these is the "Soil Carbon Amendment" to the Natural Resources Conservation Service Conservation Practice Standard that allows funding under the Environmental Quality Improvement Program (EQIP) to be provided for use of biochar and compost as soil amendments. In fiscal year 2023, EQIP reimbursed

[52] https://www.fs.usda.gov/science-technology/energy-forest-products/wood-innovation

farmers up to $194.41 per cubic yard of biochar used as a soil amendment.[53] Current prices for biochar in California are much more than this, but in Oregon, bulk biochar is available for $65 to $75/cubic yard.[54] If there is increased production of biochar in California, future prices may be closer to the EQIP reimbursement cap rate.

The second initiative is the U.S. Department of Agriculture "BioPreferred Program."[55] Created by the 2002 Farm Bill and reauthorized and expanded as part of the Agriculture Improvement Act of 2018, this program requires mandatory product purchasing procedures for federal agencies and their contractors and includes a voluntary labeling initiative for biobased products. There are 139 categories of products listed that have minimum biobased content required for purchasing. Categories that are potentially relevant to the purchase of IWPs include asphalt restorers (see below regarding bio-based asphalt), bioremediation materials (e.g., biochar), composite panels (wood wool cement panels), insulation (wood fiber insulation), lumber, millwork, underlayment, engineered wood products (mass timber), and soil amendments (biochar). Agencies are required to report their biobased purchases at the System for Award Management website. The list of "success stories" on the Biobased Program website did not indicate any examples where IWPs were used in agency projects. In many respects, the BioPreferred Program is like California's "Buy Clean Green" and "Buying Green Guide" for "Environmentally Preferable Purchasing."

The third initiative is the recent action by the U.S. Army Corps of Engineers mandating the consideration of mass timber for all vertical construction projects.[56] In 2021, the Department of Defense published a report on using mass timber in military construction projects. Under the new policy at least one mass timber design option should be explored by Corps personnel as well as contract engineers and architects who work on vertical construction projects. In cases where use of mass timber increases the square footage beyond the standard limitation, a waiver may be issued. The military has also had several projects in California and elsewhere utilizing wood wool cement panels. These include shooting ranges and other acoustically certified facilities.[57]

Support for Innovative Wood Products in California Cities and Counties

A limited review of information available indicated that there are few explicit examples of IWPs support among California cities and counties. The sheer number of mass timber projects that have been built in California, all of which required local review and approval by building officials, indicates wide acceptance of the technology. Although no explicit evidence of acceptance of other IWPs such as wood wool cement panels and wood fiber cement panels (e.g., James Hardie products) was discovered, it is known that many structures including sound walls, residential and commercial buildings, acoustic chambers, and shooting ranges have been approved by local building officials and built with those materials.

Three examples of documented recognition of mass timber benefits were found. In July 2022, the city of Emeryville passed an ordinance identifying mass timber construction as a "community benefit" because of its positive effects on GHG emissions and climate.[58] This acknowledgement

[53] https://pacificbiochar.com/nrcs-soil-carbon-amendment-808-336_faqs/
[54] https://www.chardirect.com/rogue-biochar-pricing
[55] https://www.biopreferred.gov/BioPreferred/
[56] https://www.enr.com/articles/57469
[57] Bill Bergiadis, Troy Acoustics Inc., Personal Communication, October 23, 2023.
[58] https://www.ci.emeryville.ca.us/DocumentCenter/View/14071/Item-93---Mass-Timber-Construction

qualifies residential, commercial, and industrial projects within Emeryville to receive a density "bonus" in terms of floor area, building height, or number of units if they utilize mass timber.

The second example pertains to the revocation of a ban on mass timber construction within Fire District 1 in the City of Los Angeles. That ban was put into effect at the request of the city fire department because of concerns over the flammability of wood structures. The ban was strongly supported by the cement industry. In 2022, in response to concerns expressed by architects, engineers, and builders and better information on the performance of mass timber during a fire, the ban was lifted allowing mass timber buildings in downtown Los Angeles, Hollywood, Venice, and other areas.

Finally, the third example is a bit more abstract. The City of San Diego's "Climate Action Plan" specifically refers to mass timber construction as a less carbon-intensive building material that the city can count on for helping to achieve its GHG reduction goals.[59] Unlike Emeryville, San Diego has not adopted any regulatory incentives that would encourage the use of mass timber.

In summary, the best evidence of support for mass timber is the number of projects approved by local agencies. There is virtually no evidence of support for other IWPs except in the case of the Sonoma Biochar Initiative (discussed in the following section of this report).

INNOVATIVE WOOD PRODUCT EXAMPLES

In this section, examples of successful IWP applications are briefly described. The coverage is not comprehensive; many examples could be provided for some of the products. The intent is to provide some of the more accessible illustrations, with California cases, as available. The prime benefits of IWPs are associated with their potential to reduce the carbon footprints of construction and maintenance activities. Although these benefits are incremental in some cases (e.g., use of biochar as an additive in cement and asphalt), in other cases they are relatively profound (e.g., mass timber construction). The keys to increased utilization of these products are their climate advantages in comparison to conventional materials and their ability to perform in the same or better manner. Factors that challenge their increased use include relative costs and ready availability.

Mass Timber

The number of mass timber construction projects in the U.S. and worldwide has increased dramatically over the past several years. As of October 2024, there were 2,253 multi-family, commercial, or institutional mass timber projects in progress or built in the U.S.[60] This includes 300 projects in California, which is far more than any other State.[61] Only a few are public buildings (e.g., County Building 3 in San Mateo County, Kresge College at U.C. Santa Cruz, and Sonrisa in Sacramento (described below)). The top five manufacturers of mass timber that were expected to dominate the world market in 2021 were in Europe.[62] As of 2023, Mercer Mass Timber claimed to be the largest producer of mass timber products in the U.S.[63] There are companies producing mass

[59] https://www.sandiego.gov/sustainability-mobility/climate-action/cap
[60] https://www.woodworks.org/resources/mapping-mass-timber/
[61] https://www.woodworks.org/wp-content/uploads/WoodWorks-Mass-Timber-Projects-June-2023.png
[62] https://www.imarcgroup.com/top-cross-laminated-timber-manufacturers-worldwide
[63] https://mercermasstimber.com/

timber structural products in Arkansas, Arizona, Georgia, Oregon, Washington, Idaho, Canada, Montana, Alabama, South Dakota, and Minnesota as well as Canada. There are no producers of mass timber building products in California. A few California projects are briefly described below.

In 2021, three San Francisco construction companies partnered to create TimberQuest,[64] a company providing mass timber modular classrooms. As of 2023, TimberQuest had built two mass timber school buildings for private clients: Sacred Heart School in Atherton (pictured below in Figure 1) and Stratford School in Pleasanton. As of September 2023, they were designing a school building for the Palo Alto Unified School District. TimberQuest partners (XL Construction and Aedis Architects) are also in design or completion phases for mass timber projects in Campbell and San Mateo County.

Figure 1. Sacred Heart School, Atherton

San Mateo County completed a 208,000 square foot government office building that is constructed of mass timber, including wood columns, beams, and CLT floor decks. The county claims that it is the first net zero energy design civic building in the U.S.[65] Figure 2 is an artist's rendering of the county's administration building interior.

[64] https://timber-quest.com/
[65] https://www.smcgov.org/ceo/county-office-building-3

Figure 2. San Mateo County Administration Building

As previously discussed, Sonrisa is the first residential project in Sacramento built with CLT, which was used for horizontal components (i.e., ceilings and floors). The building also features all-electric heating, low volatile organic compound materials, and low water demand landscaping. The Sonrisa project is portrayed below (artist rendering) in Figure 3.

Figure 3. Sonrisa Building

Biochar

Biochar is a stable solid, rich in carbon that is made from organic waste material or biomass that is partially combusted in the presence of limited oxygen. The qualities that make up biochar vary depending upon the material that is utilized as feedstock (e.g., timber slash, corn stalks, manure) and the temperature at which combustion occurs. The various materials and methods to produce biochar result in a wide variety of chemical and physical properties across biochar products. A common

attribute among all types of biochar is the primary ingredient: a recalcitrant carbon that can persist in soils for years or decades, and even millennia.[66]

The amount of biochar produced in the State is not documented but is not substantial when the potential for production is considered. Pacific Biochar estimated that there could be as much as 1.43 million bone dry tons of biochar per year produced from forestry operations in California.[67]

Biochar has numerous applications, but it has most promise as a soil amendment, filtration medium for stormwater and wastewater, and agent for remediation of hazardous wastes. Wakefield Biochar[68] soil amendment (see Figure 4) is commercially available at outlets such as Home Depot and Lowes, selling for $39 cubic/foot. Nationally, the average price for biochar in 2023 was $100/cubic yard or $131/metric tonne.[69] Rogue Biochar in Oregon cites a price of $70/cubic yard or about $90/metric tonne for large quantities.[70]

Figure 4. Wakefield Biochar

The Sonoma Biochar Initiative is dedicated to promoting biochar education and its sustainable use throughout California.[71] It is supported by several Resource Conservation Districts, the IBI and U.S. Biochar Initiatives, and other agencies and private companies. The initiative received three grants from CAL FIRE under the Business and Workforce Development program. One will address

[66] https://www.climatehubs.usda.gov/hubs/northwest/topic/biochar
[67] https://onlinelibrary.wiley.com/doi/10.1002/bbb.2280?af=R
[68] Manufactured in Valdosta, Georgia.
[69] https://cloverly.com/ultimate-business-guide-to-biochar/
[70] https://www.chardirect.com/rogue-biochar-pricing
[71] https://sonomabiocharinitiative.org/

emissions related to the use of Ring of Fire biochar kilns.[72] A second grant will fund a feasibility analysis for a biochar production facility in Sonoma County. The third will fund a marketing study focused on the San Francisco Bay area looking specifically at compost facilities, dairies (co-composting biochar and manure) and stormwater filtration applications. Research on biochar soil amendment effects on vineyard productivity are also underway in Sonoma County. As previously noted, Caltrans is currently experimenting with the use of biochar as a stormwater pollutant filtration method. Several scientific studies have firmly established the value of biochar for stormwater treatment.[73] The Joint Institute is developing a contract to fund a biochar marketing strategy and user guide for producers and consumers.[74]

CNC- and Biochar-Infused Cement

Incorporating CNCs produced by acid hydrolysis into cement has been demonstrated through research studies to increase its hydration and strength. The Moffett Creek bridge replacement in Siskiyou County was done with precast concrete beams using CNCs provided by the U.S. Forest Service, Forest Products Laboratory.[75] The beams were manufactured at the Knife River Prestress plant in Harrisburg, Oregon. The addition of the nanofibers resulted in similar or slightly better concrete properties when compared with conventional concrete. This was the first full-scale demonstration of CNCs as an additive for concrete. The environmental benefits of adding CNCs to cement are associated with reduced embodied carbon in the concrete due to the addition and storage of carbon. Figure 5 shows the beams being installed.

Figure 5. CNC- and Biochar-Infused Concrete Beams

[72] https://wilsonbiochar.com/
[73] https://www.sciencedirect.com/science/article/abs/pii/S0045653520307323
[74] Katie Harrell, Joint Institute for Wood Products Innovation, Personal Communication, October 19, 2024.
[75] https://www.fs.usda.gov/inside-fs/delivering-mission/deliver/bridging-gap-concrete-may-provide-new-market-opportunities

Incorporating biochar into cement has received increased attention, particularly in Europe. The benefits of adding biochar to cement and concrete include improved mechanical properties, reduced embodied carbon in buildings and road infrastructure, and potential for retention of pollutants.[76] No examples of biochar concrete projects were identified in California.

Wood Wool Cement Panels

Wood wool cement panels have been produced for decades and are commonly used as a decorative, sound-absorbing, construction, and insulation material. Commercial-scale manufacturers are located in China, Sweden, the Netherlands, and elsewhere in Europe. Troy Acoustics Corporation, located in Brunswick, Georgia, currently utilizes wood wool cement panels for a variety of projects including highway noise barriers, recording studios, commercial offices, stadiums, arenas, and shooting ranges. Pictured below (Figure 6) is one of their highway sound wall installations in California. Under the title of Acoustical Board Manufacturing Holdings Inc., Troy is currently building a 4'x 8' wood wool cement board manufacturing facility in Georgia, making it the first of its kind in the U.S. Upon completion, Troy will be the sole producer of wood wool cement boards in the country. It will produce acoustic boards in various thicknesses and ten-inch-thick construction panels for residential and commercial use. The Thomasville Payroll Authority granted 75 acres for the construction due to the projected employment of 88 workers.[77]

Troy currently obtains its wood wool cement panels from manufacturing facilities in Latvia and Sweden. It has had several projects in California. These include construction of shooting ranges for local police and sheriff's departments, including the Los Angeles Police Department, a sound wall installation at the Valencia Golf Course bordering Interstate 5 in Santa Clarita (pictured in Figure 6), and recording studios in Los Angeles. The company founder, Bill Bergiadis, holds the patent for the highest rated sound attenuation product in the world.[78] In addition to other projects in the greater U.S. for private companies, Troy has built projects for the U.S. Navy and U.S. Army on military bases in Japan, Hawaii, and elsewhere.

Figure 6. Wood Wool Cement Sound Wall

[76] https://biochar-zero.com/construction-industry/biochar-in-concrete/#:~:text=Biochar%20intended%20for%20usage%20in%20a%20concrete%20product,This%20ensures%20basic%20requirements%20for%20the%20biochar%207.
[77] Bill Bergiadis, Troy Acoustics Corporation, Personal Communication, October 1, 2023.
[78] Bill Bergiadis, Troy Acoustics Corporation, Personal Communication, October 2, 2023.

Wood Fiber Cement Panels

Wood fiber cement panels have also been widely used for construction throughout the U.S for decades. One of the main manufacturers is James Hardie company, based in Ireland, but with factories in other countries, including the U.S. Their products are commercially available in outlets such as Lowes and Home Depot. In 2022 they generated more than $3.6 billion in net sales.[79] Their primary market is one and two-family residential construction. Their U.S. headquarters is in Mission Viejo, and they have a manufacturing plant in Fontana. The degree to which their products are used in California State agency projects is not currently known. Hardie products have been identified as acceptable construction materials for projects in the "wildland urban interface."[80]

Wood Fiber Insulation

Wood fiber insulation panels, rolls, or loose material have been produced in Europe for over a decade and are recognized for superior thermal and acoustic properties. Betonwood,[81] an Italian company that also produces cement bonded particleboard, is certified by the Forest Stewardship Council for utilizing sustainably managed wood in its production process. Timber HP, a company located in Maine,[82] is the first company in the U.S. to produce wood fiber insulation. In August 2023, it made its first shipment to New Energy Works, a construction company with operations in New York and Oregon. No use of wood fiber insulation in California was discovered during the preparation of this report.

Biochar-Infused Asphalt

Asphalt covers 94 percent of paved roads in the U.S.[83] The supply of quality asphalt is shrinking, making it harder for road authorities to keep up with roadway maintenance and rehabilitation. The incorporation of biochar into asphalt has received increasing attention over the past decade, and pilot studies and research have been conducted or are underway.[84] Advantages found to date include improved temperature resistance (resulting in less volatile organic compounds and toxic emissions), increased stiffness and viscosity of asphalt binders, increased resistance to deformation, enhanced resistance to ultraviolet oxidation, and enhanced carbon storage. Incorporation of biochar into asphalt can also lower costs by partially replacing asphalt binder (at $550 per ton) with biochar (at $250 per ton) and by increasing its durability. Research is still young and there has been insufficient research on long-term durability; durability in colder climates; resistance to moisture damage and fatigue; environmental impacts; and economics, including the economics of production.

Summary of Innovative Wood Product Examples

Clearly, the amount of mass timber construction in California is the outstanding example of acceptance and deployment of IWPs in the State. Mass timber projects are mainly in the private sector, although at least one county and two private schools have employed the approach. The

[79] https://www.jameshardie.com/about-us/our-company
[80] https://stgenpln.blob.core.windows.net/document/ConstructionProjectsHandbook.pdf
[81] https://www.betonwood.com/
[82] https://www.timberhp.com/
[83] Fiscal Year 2022 APPLICATION FORM, Wood Innovations Funding Program (CFDA 10.674) (accepted and funded in FY 2022)
[84] https://biochar-zero.com/construction-industry/biochar-in-asphalt/

Sonrisa project is the only mass timber project directly sponsored by a State agency (but note there have been mass timber projects at State educational institutions, apparently designed by their architects and engineers rather than DGS or DSA). All mass timber projects depend on materials imported from other states or countries.

There is significant potential for increased use of biochar in stormwater management and agriculture, but the limited amount of biochar produced within the State and its cost relative to other materials are constraints.

The technology for wood wool cement panels is well-established, and Troy Acoustics has captured a large share of the U.S. market for that construction technique. Troy has had no experience with projects for California State agencies. Wood fiber cement panels are widely used in California for residential, commercial, and industrial construction projects.

INNOVATIVE WOOD PRODUCT CARBON CREDIT CERTIFICATION

Carbon credit certification in the context of IWPs utilization has significant potential to address both economic (carbon credit offsets have value in the marketplace) and policy objectives. Although there are no direct economic benefits to State agencies for using certified products, there would be positive public relations effects.

There are three organizations that currently provide services to document and verify carbon removal credits associated with IWPs. An additional organization (Climate Action Reserve, discussed below) is in the process of developing a certification protocol for biochar. CARB manages the carbon offset compliance program for the State. Under that program, companies or other organizations that are compelled to reduce their GHGs can purchase offset credits on the compliance market. There are no CARB-approved protocols for quantifying carbon removal or sequestration effects of wooden buildings or other IWPs. Approved protocols only relate to livestock, mine methane, ozone depletion, rice cultivation, and forests (including urban forests). As the markets and applications of IWPs increase over time, there will undoubtedly be more organizations that offer carbon credit certification services. It has been suggested that carbon offsets are an IWP in their own right.

Climate Action Reserve

Climate Action Reserve, a major certifier of carbon credits for forests and grasslands in the U.S. and Canada, is developing a certification protocol for carbon removal using biochar. Carbon removal credits are sold on the voluntary market and cannot be used to meet regulatory requirements.

Verra

Verra is headquartered in Washington, D.C. but operates internationally. The Verra Verified Carbon Standard is the world's most widely used GHG offset crediting program.[85] Verra is an International Carbon Reduction and Offset Endorsed Standard. In addition to verifying biochar carbon removal projects, its standard is applied to other removal technologies not associated with IWPs.

[85] https://verra.org/programs/verified-carbon-standard/

Aureus Earth

Aureus Earth is headquartered in Boulder, Colorado. The company's mission is to financially incentivize the most carbon efficient material technologies for construction.[86] It verifies credits for projects that store carbon and have a net positive effect on emissions. In 2022 it verified credits for the first transaction involving a mass timber building for the University of Washington Founders Hall. Its carbon offset protocol quantifies biogenic carbon stored in buildings. The resulting carbon credits can be sold on the voluntary market to help reduce the costs of construction.

Puro Earth

Puro Earth is based in Finland and offers carbon credits for engineered carbon removal projects including biochar, carbonated materials, geological stored carbon, enhanced rock weathering and terrestrial storage of biomass.[87] As with Verra and Aureus Earth, credits are only provided for net removals of carbon, and each credit equals one metric ton of CO2 removed from the atmosphere. The Puro Standard is compliant with the International Carbon Reduction and Offset Endorsed Standard.

All these entities have dozens, perhaps hundreds of approved projects. Each maintains a registry of approved projects on their websites. Beneficiaries of biochar credits include J.P. Morgan Chase; Door Dash; Dropbox, Inc.; Nasdaq, Inc.; Wakefield; and Microsoft as well as many individuals, consortia of agricultural producers, and other private companies.

Organizations that Broker Carbon Credits

In addition to the organizations that certify projects, there are organizations that broker transactions between suppliers and buyers. Carbonfuture[88] is located in Germany, and it facilitates the creation and transfer of credits for biochar and other carbon removal technologies. It works with over 120 suppliers to provide verified credits to companies throughout Europe and elsewhere. Its primary competitors are Nori, based in Seattle; AirCarbon, based in Singapore; and Flowcarbon, based in New York City.

It should be noted that several producers of CLT are certified by the Forest Stewardship Council and/or the Sustainable Forestry Initiative. These include D.R. Johnson, Kalesnikoff, Nordic Structures, SmartLam North America, Structurlam Products, and StructureCraft.[89] Proof of material sourcing from sustainably managed forests can mitigate concerns about adverse carbon impacts from timber harvest activities. When coupled with the potential for obtaining carbon offset credits for mass timber, certification for sustainable forestry practices is a potential incentive for its increased acceptance in the marketplace.

[86] https://www.aureusearth.com/
[87] https://puro.earth/
[88] https://www.carbonfuture.earth/
[89] https://www.buildwithfsc.org/post/

SECTION 2: STATE AGENCY OUTREACH

This section of the report describes findings generated from outreach to California State agency personnel regarding their procedures for selection/procurement of IWPs for their projects and for third party projects they regulate or approve. Outreach targeted specific staff (both technical and executive level) with responsibility for product testing and selection and was augmented by review of pertinent publications and websites. The objectives of this review included: 1) documenting agency procedures and evaluating the degree to which they recognize IWPs as acceptable substitutes for other materials they have historically used; and 2) identifying agency staff concerns about use of IWPs or, conversely, their suggestions for increasing consideration of their use. The findings of this outreach were used in Sections 4 and 5 for recommending changes to agency procurement procedures that would increase consideration and adoption of IWPs for State projects.

The following State agencies responded to outreach efforts:

- CARB: Anthy Alexiades, Air Pollution Specialist
- CBSC: Kevin Day, Acting Executive Director
- CAL FIRE: Mike Duggan, Technical Services Chief
- DGS: Tom Wells, Architect
- DSA: Eric Driever, Principal Architect
- Caltrans: Tim Greutert, Deputy Division Chief, Materials Testing
- LCI: Michael Maguire, Associate Planner
- OSFM: Crystal Sujeski, Chief, Code Development and Analysis
- SGC: Marc Caswell, Program Manager

Survey questions were delivered by phone, letter, and/or email, and included the following:

- Has your agency utilized any IWPs (mass timber, wood wool cement panels, wood fiber cement panels, wood fiber insulation, CNC- or biochar-infused cement or biochar) in your projects? If so, what products and what types of projects?
- If your agency has not used any of the listed products to date, has it considered their use and determined that use of other products better meets your objectives? What were the deciding criteria?
- What is the process used to determine the materials that your agency will use in its projects? Is the process documented in a set of procedural guidelines? Can you provide TSS with a copy of that document (please provide an Internet address or electronic copy of the procedures)?

Initial contacts were made via emails to executives and staff members. These initial contacts yielded few responses. Agency website searches did not reveal any published procurement protocols with the exceptions of requirements included in general mandates, such as the "California Green Buildings Code," "Buy Clean California," and "Department Sustainability Roadmaps" (as discussed in Section 1 of this report). Initial outreach was followed up with letters to agency personnel by the Joint Institute under the signature of the Joint Institute Co-Chair and Board of Forestry and Fire Protection Chair, Dr. Keith Gilless (see Appendix B). Follow-up letters were sent by Patrick Wright, Director of the Governor's Wildfire and Forest Resilience Task Force, at the

request of the Joint Institute, as the Joint Institute and Task Force have a close working relationship. The responses to all outreach efforts are described below.

Agencies Managing Construction and Maintenance

California Department of General Services

DGS is comprised of a headquarters office in Sacramento and four regional offices located in Sacramento, San Diego, Los Angeles, and Oakland. The four regional offices carry out project plan review, construction oversight, and project close-out activities. The headquarters office develops and oversees DSA programs, policies and procedures, and performs general administrative functions.

With over 150 architects, engineers, designers, and project managers, DGS is involved with much of the building design and construction completed or authorized by the State. However, there are no specific procedures for employees to follow in determining whether to incorporate IWPs in the projects they design or authorize.[90] Instead, employees rely on their individual knowledge and experience with materials, applicable legislation, building codes, regulations, and client preferences in relation to proposed projects. There may also be internal policies and interpretations that are available to designers but are not published or generally available to the public. For example, designers have reported DSA interpretations that preclude the use of mass timber as part of a building's lateral structural support system.[91]

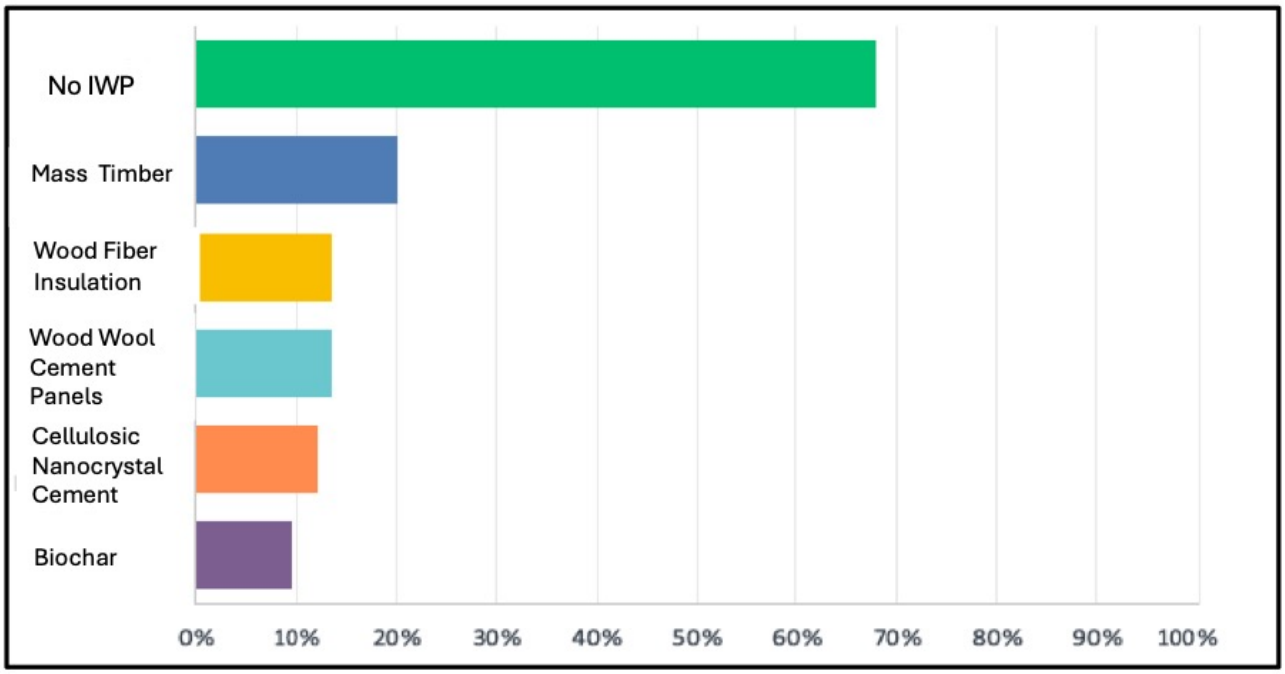
In response to inquiries, DGS developed a survey for all design team employees including DSA. The questions and results of the survey are shown below.

Question 1. Please indicate if any of your projects have used one or more of these products (IWPs as previously listed in this report).

A total of 155 DGS employees responded to this question, with two-thirds indicating that they have not used IWPs for their projects**.** Figure 7 shows DGS employee responses. Note that apparently some respondents have used more than one IWP in their projects.

[90] Tom Wells, Principal Architect, DGS, Personal Communication, October 13, 2023.
[91] Lisa Podesto, Director of Mass timber and Construction Innovation, Swinerton, Personal Communications, June 22 and August 7, 2024.

Figure 7. DGS Staff Responses Regarding Use of Innovative Wood Products

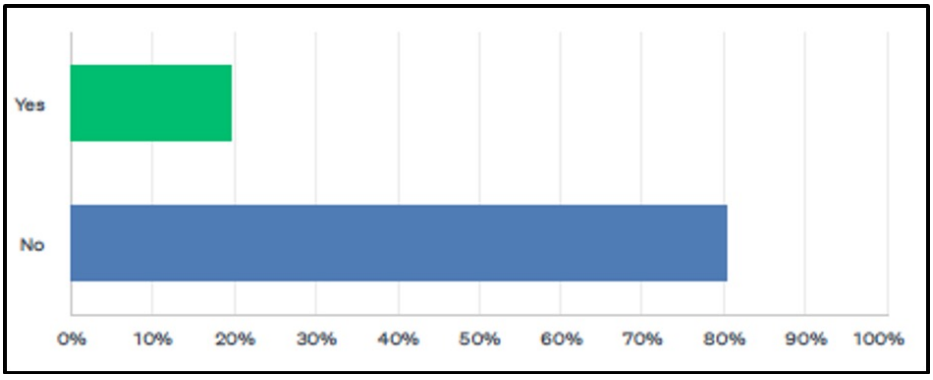


It is notable that these responses seemed to contradict information obtained through other sources. For example, only one example of CNCs use in California has been identified, and it was in a bridge construction project in Yreka (not a State-sponsored project). Additionally, wood fiber insulation is not generally available in the State. The only producer in the U.S. is in Maine and the nearest outlet for it is in Reno.

Question 2: If your projects have not used any of the above, were any considered?

There were 148 responses and only 20 percent (29) had considered using IWPs. Figure 8 shows DGS employee responses.

Figure 8. DGS Staff Responses Regarding Considering Use of Innovative Wood Products



The responses to this question also seemed to contradict the answers to the first question. For example, in response to the first question, 31 respondents indicated that they had used mass timber in their projects.

Question 3: Provide examples of your projects that have included use of IWPs.

Eight individuals provided some detail on their projects:

- Glulam was used as cladding panels throughout the building envelope at Bateson Renovation project. This 308,000 square foot building occupies a full city block in Sacramento and was designated a historically significant building in 2016.
- CLT was used for a residential center multipurpose building (location unknown).
- Glulam beams were used in CAL FIRE projects (locations unknown).
- Glulam was used in an outdoor dining shade structure at a skilled nursing facility (location unknown).
- Glulam was used for an internal floor framing system at the CAL FIRE Santa Cruz auto shop.
- CLT and glulam were used at a Richards Boulevard office complex in Davis.
- Wood wool cement panels were used to install a roof (location unknown).
- Residential mid-rise "podium" projects were built using glulam (locations unknown).

Unfortunately, in addition to the low number of projects described and the relative lack of detail, all responses were anonymous, and it was not possible to follow up with designers to inquire about how they made their choices of materials for construction. None of the projects involving mass timber are identified on the WoodWorks website.[92] Moreover, as noted below, the use of glulam in CAL FIRE projects conflicts with what a CAL FIRE representative reported about costs of glulam precluding its use for their projects. It is likely that the reported use of glulam by DGS indicates that CAL FIRE designers were not involved with these projects.

California Department of Transportation

Caltrans manages more than 50,000 miles of California's roadway, provides inter-city rail services, issues and administers permits for more than 400 public-use airports and special-use hospital heliports, and works with local agencies on improvements to local transportation systems. Caltrans has six primary programs: Aeronautics, Highway Transportation, Mass Transportation, Transportation Planning, Administration, and the Equipment Service Center. Among its core values is, "We are empowered to seek creative solutions and take informed risks." [93]

The potential uses of IWPs by Caltrans include biochar for landscape maintenance and water retention as well as for storm drainage filtration. There is also potential for utilizing CNC- and biochar-infused cement and biochar-infused asphalt for paving and bridge construction. Wood wool cement panels have been used for at least one sound wall (on private property) next to a California highway and has potential for use by Caltrans as noise barriers.

[92] https://www.woodworksinnovationnetwork.org/projects/
[93] About Caltrans | Caltrans

For storm drainage filtration and landscaping, Caltrans has found that biochar will break down to very fine sizes under compaction and does not stay in place unless it is covered with another material. Caltrans also found that many suppliers do not test the material to IBI standards. This is viewed as a quality control issue by Caltrans. Research into the use of biochar for storm water filtration is continuing and there is one experimental application located at the intersection of I-680 and I-80 in Cordelia.[94] The use of biochar in landscape maintenance or design is not planned. While Caltrans uses wood mulch, biochar is not included in soil amendments. Further, there is no research currently being undertaken into its possible landscaping applications, including water retention and nutrient retention due to reduced leaching.[95]

The use of wood wool cement panels for sound walls along freeways has been proposed by proponents of the technology.[96] Caltrans has not conducted research necessary for it to be adopted as a suitable alternative to conventional materials, and there are no plans to do so. Instead, Caltrans is studying the potential for the development of concrete masonry units (CMU),[97] which incorporate substantially more fly ash (50 percent) than Portland cement (15 percent).[98]

For pavement applications, there has been considerable research completed and continuing at the U.C. Davis Pavement Research Center and Oregon State University (and elsewhere). Some studies have presented findings supporting the addition of CNCs to Portland limestone cement or biochar-infused asphalt. The French firm Effage is testing a plant-based asphalt called biophalt on one mile of road in France.[99] A great deal of research is still needed to address the potential benefits of adding cellulose (biochar, rice straw, pine oil, etc.) to cement or asphalt. Caltrans is currently supporting a study at U.C. Davis looking at 14 combinations of concrete mixtures including several different forms of cellulose.[100] Given the time needed for product discovery, development, and commercialization, it does not appear that paving material with wood fiber or other plant-based material will be available within the short-term.

California Department of Forestry and Fire Protection

CAL FIRE is dedicated to fire prevention, fire protection, and stewardship of over 31 million acres of California's wildlands. In addition, it provides a variety of emergency services in 36 counties via contracts with local governments. It also enforces California's Forest Practice Regulations on private and other non-federal lands.[101] Through the OSFM, CAL FIRE provides input on modifications to the model building codes before adoption in California.

CAL FIRE is responsible for the design of their buildings with oversight from DGS. Buildings are categorized as essential or non-essential. Essential buildings include fire stations, command centers, and air bases. Non-essential buildings include dormitories and training facilities. CAL FIRE has

[94] Jeremiah Ketchum, Division Chief of Environmental Analysis, Caltrans, Personal Communication, December 22, 2023.
[95] Jeremy Ketchum, Division Chief of Environmental Analysis, Caltrans, Personal Communication, December 12, 2023.
[96] Martin Twer, Biomass Program Director, The Watershed Center, Personal Communications, August 2023.
[97] Tim Greutert, Chief of the Materials Engineering and Testing Services subdivision, Caltrans, Personal Communication, February 20, 2024.
[98] Concrete Masonry: An Optimized Low Carbon Wall (angelusblock.com)
[99] French Company Eiffage Is Testing Plant-Based Asphalt Called Biophalt (rideapart.com), September 28, 2022.
[100] Dr. John Harvey, U.C. Davis, Personal Communication, February 22, 2024.
[101] California Department of Forestry and Fire Protection | CAL FIRE

3,000 total structures, including 236 fire stations. Current and foreseeable budgets provide for the replacement of 10 structures per year. According to CAL FIRE staff, the Department is unable to use glulam due to its cost and unavailability of suppliers in California. When putting projects out to bid, glulam and CLT are not cost competitive in comparison to steel and concrete.[102] Note that in response to the survey of DGS designers, the use of glulam at CAL FIRE facilities was reported.

In addition to cost, potential fire and earthquake considerations also affect the choice of materials by CAL FIRE. Experimental tests have indicated that mass timber performs well when exposed to fire and under seismic stress.[103] [104] Existing budget constraints and preconceptions about advantages of steel and concrete compared to mass timber suggest near-term wider use of mass timber by CAL FIRE is not likely under current procurement procedures. There is no evidence of other IWPs use by CAL FIRE for its construction or maintenance projects.

Agencies Administering Grant and Loan Programs

California Strategic Growth Council

California lawmakers established the SGC in 2008 to support sustainable community development in California. The Council's mission is to promote State agency coordination to improve air and water quality and natural resource protection, increase the availability of affordable housing, improve transportation, reduce GHG emissions, and support climate change adaptation and resilience.[105] Among its programs, it selects grantees for the Affordable Housing and Sustainable Communities program (AHSC). This is an important part of California's climate and equity strategy, funding affordable housing developments (new construction or renovation) and transportation infrastructure. The grants are processed and administered by HCD.

The AHSC guidelines for evaluating proposed projects contain no preference for the types of materials used in the construction of their projects if they meet CBC and other California requirements. If multi-story buildings are proposed for grant funding, there would be an opportunity to employ the use of IWPs for structural support, floors, and ceilings. This could be encouraged by modifications to the grant guidelines to mandate consideration of the use of IWPs because of their potential life cycle carbon benefits as compared to other construction materials (see Section 4, Recommendations).

California Energy Commission

CEC administers the Building Initiative for Low Emissions Development (BUILD) program. It is designed to provide technical assistance and incentives for new, all electric low-income residential buildings that reduce GHG emissions. The program was authorized by Senate Bill 1477 (Stern, Chapter 378, Statutes 2018). An implementation plan and final guidelines were approved by the CEC and then approved by the California Public Utilities Commission on February 28, 2022.[106] The

[102] Mike Duggan, Assistant Deputy Director, CAL FIRE, Personal Communication, December 12, 2023.
[103] https://www.woodworkingnetwork.com/news/canadian-news/new-research-confirms-mass-timbers-fire-safety-taller-buildings
[104] 10-story Timber Rocking Frame Sails Through Seismic Shake Tests | Engineering News-Record (enr.com), May 9, 2023
[105] 20230609-SGC_2022_Annual_Report.pdf (ca.gov)
[106] Building Initiative for Low-Emissions Development Program - BUILD | California Energy Commission

guidelines exclusively relate to electricity and do not address the potential for other approaches to reducing GHG emissions (such as use of IWPs).

The CEC also administers a grant program entitled The Next EPIC Challenge: Reimagining Affordable Mixed-Use Development in a Carbon-Constrained Future (GFO-20-305). This solicitation provides up to $48 million per year for a design-build competition that challenges multi-disciplinary project teams to design and build mixed-use developments using innovative energy technologies, tools, and construction practices. The objective is to create designs that are affordable, equitable, emissions free, and resilient to climate change impacts and extreme weather events.[107] As the CEC articulates, "Building decarbonization – primarily achieved through energy efficiency, onsite renewable generation and storage, and full end-use electrification – is a key strategy for realizing the State's goals to reduce greenhouse gas emissions."[108] Four projects that were awarded funding in 2023 are listed on the CEC website.[109] None of the projects proposed IWPs as an option for creating designs that are emissions free and resilient to climate change. Grant evaluation guidelines do not create incentives for use of IWPs but could be modified to address this (see Section 4, Recommendations).

Agencies Regulating Construction

California Building Standards Commission

The CBSC manages the development of the CBC and the California Green Standards Building Code (CalGreen). CalGreen applies to nonresidential structures that include new buildings or portions of new buildings, additions and alterations, and all occupancies. Any State department can recommend changes to codes during annual evaluation cycles. In the past, the OSFM and other agencies proposed changes to allow use of mass timber for multi-story buildings. These changes, which allowed mass timber construction for buildings up to 18 stories, became part of the CBC in 2021. Future changes allowing more exposed wood in mass timber construction, (currently part of the 2024 IBC), will likely be adopted in California in 2025 unless adoption is accelerated through an Intervening Code Cycle.[110] Additional changes, like modification of the Title 24 requirement for continuous monitoring of mass timber production for certain state projects could be proposed by the DSA or the Office of Statewide Health Planning and Development (see Section 4, Recommendations).

Assembly Bill 2322 (signed into law in 2022) requires mandatory building standards for fire resistance based on occupancy risk categories in moderate, high, and very high fire severity zones in State Responsibility Areas, local responsibility areas, and on land designated as a Wildland Urban Interface area by cities and other local agencies under specified provisions of the CBC. This law requires those building standards to apply to nonresidential, critical infrastructure buildings and to include certain fire rating requirements for structures under specified risk categories. The 2022 CBC, Title 24, Part 2, Chapter 7A sets forth criteria for materials and construction methods for exterior wildfire exposure. Section 707A.4 permitted exterior wall assemblies include:

[107] GFO-20-305 - The Next EPIC Challenge: Reimagining Affordable Mixed-Use Development in a Carbon-Constrained Future
[108] GFO-20-305, Solicitation Manual, December 2020
[109] https://www.energy.ca.gov/media/9124
[110] Ibid.

"An assembly of sawn lumber or glue-laminated wood with the smallest minimal nominal dimension of four inches. Sawn or glue-laminated planks splined, tongue-and-groove, or set close together and well spiked."

Mass timber construction is permitted in moderate to very high fire severity zones with the provision that exterior cladding provides increased safety during a fire. In addition, taller buildings are required to have a certain percentage of gypsum-covered surfaces.[111] As indicated below, the satisfactory performance of mass timber during a fire has been established through research and testing.

Department of General Services – Division of the State Architect

DSA is a branch of DGS. It develops accessibility, structural safety, and historical building codes and standards governing the construction of various public and private buildings throughout California, including K-12 schools and community colleges.[112] Through CalGreen,[113] DSA regulates sustainable practices that reduce negative impacts on the environment or provide a positive environmental impact as they relate to projects regulated by DSA. These mandatory measures target energy efficiency, water efficiency, water conservation, material conservation, resource efficiency, and environmental quality.[114] To promote sustainability, DSA collaborates with stakeholders, experts, and public entities to develop green regulations that govern the construction of buildings in California. It proposes changes to the CBC and it develops and publishes interpretations of code, policies, and procedures necessary for stakeholder understanding and coordination of enforcement among the DSA regional offices.

DSA is one of several State agencies that propose changes to the California Building and Administrative Codes through the CSBC's rulemaking process. The creation of regulation is directed through law. Regulations govern how the law will be enforced.[115] Its authority for State-funded construction is often limited to the accessibility provisions for persons with disabilities and renovations to State-designated historic structures where they have plan review and approval authority only. DSA could have a role in enabling wider use of IWPs through changes to the CBC and in fact supported such changes in 2019 (see Section 1 of this report).[116]

The California Code of Regulations requires continuous monitoring of structural glulam and CLT production for some State projects.[117] Continuous monitoring is defined in code as:

*"The manufacture of all structural glued laminated and cross-laminated timber shall be continuously inspected by an approved agency (*approved agency is not defined*). The approved agency shall verify that proper quality control procedures and tests have been employed for all materials and the manufacturing*

[111] Crystal Sujeski, Chief of Code Development and Analysis, Office of the State Fire Marshall, Personal Communication, March 27, 2024.
[112] About Us (ca.gov)
[113] https://www.dgs.ca.gov/BSC/CALGreen, California Code of Regulations, Title 24, Part 11,
[114] Sustainability Plan Review (ca.gov)
[115] CALGreen Code Development
[116] Eric Driever, Principal Architect, Architectural Codes and Standards, DSA, Personal Communication, October 30, 2023
[117] Title 24, California Code of Regulations, Sections 1701.A.1.1., 1705A.5.5. and 1705.5.5

process and shall perform visual inspection of the finished product. Each inspected member shall be stamped by the approved agency with an identification mark." [118]

This applies to structures subject to regulation by DSA (e.g., public elementary and secondary schools, community colleges, and State-owned or State-leased essential services buildings) and/or by the Office of Statewide Health Planning and Development (e.g., hospitals and correctional treatment centers). Since there are only a few inspectors in the State certified to conduct these inspections and all production occurs outside the State, this requirement imposes a significant constraint on use of mass timber in projects designed or authorized by those two state agencies. An alternative process that would permit inspectors to be certified at factories or allow other means of wholesale certification would incentivize greater use of these products.[119] Representatives from WoodWorks are attempting to find alternatives to continuous monitoring by working with the DSA.[120] See Section 4, Recommendations.

Office of State Fire Marshal

The OSFM Code Development and Analysis Division reviews all of California's regulations relating to fire and life safety for relevancy, necessity, conflict, duplication, and/or overlap. The OSFM prepares the California State Fire Marshal's fire and life safety regulations and building standards for review and adoption by the CBSC.[121] In 2022, then State Fire Marshall Mike Richwine, went on record with the following statement:

"The early adoption of mass timber codes can be a benefit to California in many ways, but I would like to highlight three of those advantages in this proposal (referring to changes that allow mass timber multi-story structure*). Number 1, it has the potential to increase the market demand for mass timber production in California to meet the needs of the construction industry. Number 2, it will increase the pace and scale of our wildland fire prevention and forest management goals of treating 500,000 acres per year by thinning the forest of smaller diameter trees that can be used in the production of cross laminated timber and other mass timber assemblies. And while wood products provide the benefit of storing carbon, another benefit or advantage is that mass timber construction can also help reduce the carbon footprint of concrete and steel production."*[122]

Regarding performance of mass timber buildings when exposed to fire, studies have found that it can out-perform concrete and steel because of its propensity to char, forming a protective layer while retaining strength. This slows combustion significantly, allowing time for safe evacuation and facilitating suppression.[123]

California Air Resources Board

CARB's mission is to promote and protect public health, welfare, and ecological resources through effective reduction of air pollutants while recognizing and considering effects on the economy. It is also responsible for taking actions to fight climate change.

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[118] Op Cit
[119] Matt Larson, Preconstruction Director, XL Construction, Personal Communication, February 9, 2024.
[120] Chelsea Drenick, Regional Director, WoodWorks, Personal Communication, April 22, 2024.
[121] Code Development and Analysis (ca.gov)
[122] https://www.ci.emeryville.ca.us/DocumentCenter/View/14071/Item-93---Mass-Timber-Construction
[123] https://www.naturallywood.com/wood-performance/fire/

CARB plays several roles in the potential use of IWPs. While it defers to Caltrans regarding testing and use of materials that may reduce air pollution, CARB could promote research into reducing volatile organic compounds and toxic pollutant emissions through use of biochar-infused cement and asphalt.

In September 2022, Governor Newsom signed Assembly Bill 2446 (Holden), which requires CARB to develop a framework for measuring and reducing the embodied carbon of building construction materials, primarily at the materials production stage, with a target of 40 percent net reduction in GHG emissions associated with buildings, no later than the end of 2035, and an interim target of a 20 percent net reduction by the end of 2030. Overall, California has committed to reducing GHG emissions by 55 percent below 1990 levels by 2030 and achieving carbon neutrality no later than 2045.[124] The State has made (and continues to make) considerable progress in reducing GHG emissions from buildings through energy efficiency, clean renewable energy, and building electrification. As a result, embodied carbon in the materials used to construct buildings represents most remaining building-related emissions.[125]

Embodied carbon refers to the life cycle GHG emissions resulting from the extraction, manufacturing, transportation, installation, maintenance, and disposal of goods, including building materials. Tackling embodied carbon in new construction is critical for ensuring that California can achieve its housing and climate goals, because housing production in California is anticipated to increase significantly over the next 10 years.[126]

CARB's efforts to implement AB 2446 are focusing on in-depth assessments of technology, market, cost-effectiveness, and policy instruments. According to CARB, research indicates that embodied carbon can be reduced through strategies such as the optimal use of building materials with high-recycle material content or low embodied carbon. LCAs will be a key component of the successful implementation of AB 2446. There are several published LCAs comparing construction with mass timber versus concrete and steel with results favoring the use of mass timber.[127] CARB is also assessing the potential for creating factory built affordable housing with mass timber, an approach that is a centerpiece of the Oregon Mass Timber Coalition.[128] Note that CARB is on record expressing concern that the benefits of using IWPs to meet embodied carbon reduction requirements will depend on the source of materials used to produce IWPs. If materials are sourced from unsustainable forest practices, their benefits will be accordingly reduced.[129]

Regarding the use of biochar for stormwater filtration or hazardous waste treatment, the issue of disposal of biochar after it has been used was raised by CARB staff as a potential concern.[130]

CARB is not involved with evaluating alternatives to conventional cement or pavement, but Senate Bill 596 requires CARB to develop a strategy for the cement industry to achieve net zero emissions

[124] https://www.gov.ca.gov/2022/08/12/governor-newsoms-ambitious-climate-proposals-presented-to-legislature/
[125] https://legiscan.com/CA/text/AB2446/id/2607014
[126] https://www.hcd.ca.gov/regional-housing-needs-allocation.
[127] https://www.mdpi.com/journal/sustainability/special_issues/mass_timber_sus
[128] Conference call with CARB staff on February 24, 2024.
[129] Alexander Mitchell, Manager, Building Embodied Carbon Analysis Section, CARB, Personal Communication, August 9, 2024.
[130] Conference call with CARB staff on February 24, 2024.

by 2045.[131] The strategy was due on July 1, 2023. In 2022 and 2023 CARB staff initiated a process to obtain stakeholder input on the draft strategy. It has not been completed yet.[132]

Summary of Agency Procurement Procedures

Our outreach to State agencies and review of information posted on their websites indicates that they do not have specific, identifiable procurement procedures or policies directly focused on utilization of IWPs in State-sponsored projects. In the case of DGS, survey results indicate that some designers have used IWPs for their projects, but the vast majority (80 percent) have not considered their use. It is unknown if lack of consideration is based on lack of personal knowledge or other factors.

Regarding Caltrans, there is no evidence that IWPs including biochar, wood wool cement panels, or CNC- or biochar-infused cement or biochar-infused asphalt will be deemed acceptable products for use in their sponsored projects any time soon.

Some CAL FIRE projects designed by DGS have used IWPs. CAL FIRE is on record, however, that products such as glulam are too costly for use in projects that it sponsors.

Agencies administering grant programs targeting affordable housing and carbon-neutral development (e.g., SGC and CEC) could incentivize use of IWPs by favoring proposals that utilize them. At the present time, that is not the case. It should be noted, however, that the first affordable housing project implemented under the mandate of EO-N-06-19 (Sonrisa) was a mass timber project.

There are obstacles to wider use of IWPs by State agencies that are outside the purview of their procurement procedures. The absence of IWP producers in California may affect cost and availability of IWPs. For example, continuous monitoring of structural glulam and CLT production, as required by Title 24 for some State projects, may affect the cost of using mass timber produced outside of California. "Buy California" requirements may also affect the potential for use of products from other states. In summary, the outlook for wider use of IWPs by State agencies is quite limited under existing procurement practices and market conditions.

SECTION 3: OUTREACH TO VENDORS AND DESIGNERS

Vendors and producers of IWPs that are readily available in the marketplace (including mass timber, wood wool cement panels, and wood fiber insulation) were surveyed to determine to what extent they have successfully marketed their products in California. Producers of biochar- and/or carbon-infused cement and asphalt were not contacted as part of this project because the likelihood of State agencies adopting their use will depend on the outcome of ongoing research and experimentation and they are not currently readily available in the marketplace. Companies that provide materials or services that complement mass timber construction were also contacted. Vendors were identified through searches on the Internet, review of information on the WoodWorks website, and consultation with knowledgeable individuals associated with design and IWP advocacy

[131] https://pluralpolicy.com/app/legislative-tracking/bill/details/state-ca-20212022-sb596/783391.
[132] Haley Hamza, Air Pollution Specialist, California Air Resources Board, Personal Communication, April 2, 2024.

organizations. By way of email to identified contacts or through portals on their websites, they were asked the following series of questions.

- What are your primary markets in the U.S.?
- Have you faced any obstacles to doing business in California? What is the nature of those obstacles?
- If you have done business in California, what products have you sold there?
- Who are your clients in California (private sector architects/designers; engineers; construction contractors; city, county, or State agencies; federal agencies)?
- How do you market your products in California?
- What can the government of the State of California do to help you improve your sales in California?

A description of the TSS research project and the role of the Joint Institute was included in the email to vendors.

In addition to sending surveys to individuals identified as sources of information regarding IWP sales, their websites were reviewed for relevant information. Returns of questionnaires sent to vendors were minimal. The reasons for this are uncertain but may include companies considering the information requested as proprietary. Due to limited participation, the information provided in this section of the report has primarily been obtained from websites and from interviews with knowledgeable industry representatives.[133]

To supplement information obtained from vendors, designers and builders involved with IWP projects in California were consulted to determine what their experience was with implementing projects. These individuals and companies were identified through review of project descriptions on the WoodWorks website.[134] Designers and builders were asked what criteria they used to select IWPs for their projects and what, if any, obstacles they overcame in completing their projects.

Vendor Outreach

Twenty-two vendors were contacted and are listed in Table 2.

[133] Chelsea Drenick, Regional Director, Woodworks.org, Personal Communication, April 22, 2024.
[134] https://www.woodworksinnovationnetwork.org/projects/

Table 2. IWP Vendors Contacted

Vendor	Products	Website	Location
Eltomation B.V.	Wood wool cement panels	https://www.eltomation.com/eng/about-us/	Netherlands
Wood Wool Acoustic Panels Manufacturer		https://www.panelsforwalls.com/	China
StrandTec		https://www.asiarchitectural.com/products/strandtec/	Minnesota
Troldtekt		https://www.troldtekt.com/	Denmark
Western Forest Products	Mass timber	https://www.westernforest.com/products/	British Columbia
Mercer Mass Timber		https://mercermasstimber.com/	British Columbia, Arkansas, Washington
SmartLam North America		https://www.smartlam.com	Alabama
D.R. Johnson Lumber Company		https://www.drjwoodinnovations.com	Oregon
Freres Engineered Wood		https://frereswood.com	Oregon
Rosboro Manufactured Timber		https://rosboro.com/	Oregon
Vaagen Timbers		https://vaagentimbers.com	Washington
Nordic Structures		https://www.nordicclt.com	Quebec
American Laminators		https://www.americanlaminators.com/index.html	Oregon
Zip-O Laminators		https://zipolaminators.com/	Oregon
Hasslacher Norica Timber		https://www.hasslacher.com/	Austria
Sterling Structural		https://www.sterlingstructural.com/	Illinois
RedBuilt		https://www.redbuilt.com	Idaho
Kalesnikoff Lumber Company		https://www.kalesnikoff.com/	British Columbia
Global IFS		https://www.globalifs.com/	Michigan
TimberHP	Wood fiber insulation	https://www.timberhp.com/	Maine
James Hardie	Wood fiber cement panels	https://www.jameshardie.com/	Ireland (world-wide)
Equitone		https://www.equitone.com/	Tennessee

Of these, the following responded directly to our questions:

- Rosboro Manufactured Timber
- Hasslacher Norica Timber
- Global IFS
- RedBuilt
- TimberHP
- Sterling Structural

Despite the lack of direct responses to our questions, the information on vendor websites and at the WoodWorks website was sufficient to assess to what extent they had successfully marketed their products in California, particularly to State agencies. As a result of outreach and review, it was determined that the primary IWPs that are currently used at scale in California are mass timber and

wood fiber cement panels (i.e., James Hardie panels) used extensively for residential and commercial construction and readily available at big box outlets in California such as Home Depot and Lowes. Wood wool cement panels are also used for specialty projects such as acoustical chambers (e.g., recording studios, shooting ranges and entertainment venues). There are no publicly available examples of wood fiber insulation being used within the State, although some local applications are likely. Therefore, the focus of this section is on mass timber.

Emerging Producers

Outreach to vendors included a discussion with an emerging IWPs production enterprise. Fabric Workshop (FW) is a California-based organization that has obtained an industrial zoned, 30-acre property located in Redding. FW expects to begin production of mass timber by late 2027. Glue laminated and CLT products will be fabricated from lumber supplied by local mills. Supply agreements are being negotiated with mills located in Trinity, Lassen, and Tehama Counties. The Chief Executive Officer of Fabric estimated the expected production capacity on the order of 100,000 m^3, requiring approximately 70 million board-feet of lumber per year.[135] Other than this project, no definite examples of future IWPs produced at scale in California were identified. There are reports of some mill operators considering the potential for fabricating dowel joined CLT, such as Schmidbauer Group.[136] There is also an organization called Urban Machine using robotics to reclaim lumber that could potentially be used to create mass timber.[137]

Designers and Builder Outreach

Designers, specialty contractors, and builders involved with mass timber projects in California were identified through review of project descriptions on the WoodWorks website. WoodWorks is an organization funded by the timber industry and U.S. Forest Service that is focused on educating developers, designers, and builders.[138] Designers and builders were contacted to inquire about their decision-making regarding mass timber as well as any issues they encountered in completing their projects (e.g., delays, costs, and availability of design and construction expertise). Some of the projects these companies were involved with included:

- University of Southern California Hub Student Housing
- U.C. Santa Cruz Kresge College Renewal
- Sonrisa affordable housing (Sacramento)
- San Mateo County Office Building No. 3 (Redwood City)
- Del Mar Civic Center
- U.C. Davis Latitude Dining Commons
- Double Ground at California College of the Arts (San Francisco)
- U.C. Los Angeles Margo Leavin Graduate Arts Studio
- Sunnydale Community Center (San Francisco)
- Caltech Resnick Sustainability Center (Pasadena)

[135] Scott Ehlert, CEO and Head of Design, Fabric Workshop, Personal Communications, February 22, 2024.
[136] George Schmidbauer, Schmidbauer Group – is planning DLT production operations at their North Fork Timber mill in Korbel.
[137] https://urbanmachine.build/
[138] https://www.woodworksinnovationnetwork.org/projects/.

Table 3 lists the 13 mass timber designers and building firms contacted.

Table 3. Mass Timber Designers and Builders Contacted

Designers & Builders	Services	Website	Location
TimberQuest	Mass timber designer and builder	https://timber-quest.com/	San Jose
Western Wood Structures	Mass timber engineers and builder	https://westernwoodstructures.com/clt-mass-timber/	Oregon
StructureCraft	Mass timber engineers and builder	https://structurecraft.com/	Washington State
Timberlab	Mass timber engineers and builder	https://timberlab.com/	Oregon
Antunovich Associates	Architects	https://antunovich.com/about	Los Angeles
Studio Gang	Architects	https://studiogang.com/	San Francisco
Holmes Engineers	Engineers and designers	https://www.holmes.us/	San Francisco
Skidmore, Owings and Merrill	Architects and engineers	https://www.som.com/	San Francisco
Miller Hull Partnership	Architects	https://millerhull.com/	San Diego
HED	Architects and engineers	https://www.hed.design/	San Diego
Johnston Marklee	Architects	https://www.hed.design/	Los Angeles
Leddy Maytum Stacy	Architects	https://www.lmsarch.com/	San Francisco
Cannon Design	Architects	https://www.cannondesign.com/	Southern California

Of the companies listed in Table 3, the firms that directly responded to our request for information included:

- TimberQuest
- Antunovich Associates
- Studio Gang
- Miller Hull Partnership
- Cannon Design

Telephone interviews and virtual meetings were arranged with individuals representing these companies. All information obtained during those interviews and described below is presented anonymously at the request of the individuals. In addition to these interviews, websites of these companies provided supplemental information on their experiences with mass timber projects.

Projects in California

Mass Timber

The WoodWorks website maintains a list of mass timber projects throughout the U.S., cataloged by state. It also includes descriptions of 69 California projects (as of October 2024). The projects listed

there are located primarily in the Bay Area and Sacramento and, to a lesser extent, in Southern California.[139]

For many of the projects listed on the WoodWorks website, the supplier of mass timber is not identified. Those suppliers that were identified are summarized below:

- 1510 Webster, Oakland – Freres Engineered Wood, Oregon
- Orange County Sanitation District Offices – Nordic Timber, Quebec
- 10 Story Shake Table (Seismic Test) – Freres Engineered Wood, Oregon
- MacLac Building D, San Francisco – RedBuilt LLC, Idaho
- 2100 Kettner, San Diego – Swinerton Mass Timber/TimberLab (builders), Oregon
- Westmark Lower School, Los Angeles – Western Wood Structures (fabricators/builders), Oregon
- Sunnydale Community Center – Kalesnikoff Lumber Company, Swinerton Mass timber/TimberLab, British Columbia, Oregon
- Project 1, Oakland – Freres Engineered Wood, Oregon
- Mighty Ducks Practice Facility – Western Wood Structures, Oregon
- Kind, Sacramento – Kalesnikoff Lumber Company, British Columbia
- Sacred Hearts Schools, Atherton – Kalesnikoff Lumber Company, British Columbia
- County Building #3, Redwood City – SmartLam North America, Alabama
- Church, Oakland – Western Wood Structures, Oregon
- Girl Scout Camp, Frazier Park – Freres Engineered Wood, Oregon
- Sonrisa, Sacramento – Kalesnikoff Lumber Company, British Columbia
- U.C. Santa Cruz Kresge College, Santa Cruz – Swinerton Mass Timber/Timberlab and Hasslacher Norica Timber, Oregon, Austria

Vendor websites listed in Table 3 provided additional information on projects in California. California is one of the largest markets for Global IFS flooring systems. Global IFS is in partnership with WoodWorks to promote the use of their raised floor solutions in mass timber projects. They market their products through presentations to architects and engineers and through websites, social media, and joint presentations with WoodWorks. SmartLam has provided building materials for projects in Marina Del Rey, Pomona, and San Mateo County. D.R. Johnson has provided building materials for projects at Chabot College in Long Beach and for oWOW in Oakland. Vaagen Timber has supplied material to projects in San Jose, Gualala, and Irvine. Mercer Mass Timber provided building materials for the Microsoft Silicon Valley Campus in Mountain View. American Laminators has provided material for at least two projects in California in Santa Maria and Long Beach. Rosboro distributes their products west of the Mississippi, including California, where they have provided glulam beams, columns, and decking. Their clients in California include wholesale distributors and Rosboro markets through AIA's continuing education classes for engineers and architects. RedBuilt LLC (recently acquired by Hampton Lumber Company) maintains a design center in Chino, California. They do not manufacture mass timber in California, however, the Chino facility manufactures trusses. They work with designers to incorporate their trusses into mass timber projects.

[139] https://www.woodworksinnovationnetwork.org/projects/

Given the large number of mass timber projects completed, in design, or in construction within California, mass timber suppliers have made significant contributions to help expand the market within the State. As noted in the above listing, a few of these projects are in the public sector, but most are in the private sector. Only a few would be considered State agency projects (e.g., Sonrisa, U.C. Santa Cruz Kresge College, Chabot College, U.C. Davis Latitude Dining Center, U.C. Los Angeles Graduate Art Studios). Others are local agency projects (e.g., Long Beach Civic Center, Del Mar Community Center, San Mateo County Building #3).

Wood Wool and Wood Fiber Cement Panels

There are several manufacturers of wood wool and wood fiber acoustic panels located throughout the U.S. and in Europe and China. Troy Acoustics, a designer and installer of wood wool cement projects, was formerly located in California, but moved to Georgia in 2013 due to a more favorable business tax environment. They have sold and installed imported European wood wool cement panels in California for highway sound barriers (on private land), shooting ranges (indoor and outdoor), gymnasiums, animal shelters, recording studios, and sound stages. Their California clients have included county sheriff's departments, the U.S. Navy and Marine Corps, mass media and entertainment companies, and a private golf course. They primarily market products in California via architects and engineers, but also successfully market through their website. Troy is in the pre-construction process of building a factory in Georgia that will be the first wood wool cement board factory in the U.S. The factory will produce both acoustical panels and panels that can be used for housing.[140]

According to its website, Equitone fiber cement panels have been used for projects in San Diego and Siskiyou County. Its panels are suitable for both roofing and facades. Equitone did not respond to requests for further information. The websites for Steico and Gutex wood fiber insulation did not provide any information on exports to the U.S. or California.

James Hardie's website notes that they have been producing wood fiber cement panels in the U.S. since the 1980s. They have a U.S. headquarters in Mission Viejo, CA; a production facility in Fontana, CA; and three building supply outlets in California. They have production facilities in several other countries, including New Zealand, Australia, and the Philippines. Their products are used for siding and soffits and are replacements for stucco and wood siding. They market through retail and wholesale distributors including Home Depot, Lowes, and other building materials suppliers. One of the features attributed to wood fiber cement construction is resistance to damage from fire.

Other Innovative Wood Products

There are very few examples of IWPs other than mass timber and wood wool/wood fiber cement panels being used in California and none of these are at a commercial scale. Experimental projects utilizing CNC-infused cement and biochar have been implemented and there are limited sales of biochar for agricultural and gardening applications. There are no known examples of wood fiber insulation use for State projects and the TimberHP website does not indicate any sales in California. Their nearest distributors are in Reno and Las Vegas. Research on biochar-infused asphalt and cement is underway at the University of Oregon and U.C. Davis. Additional research on the use of

[140] Bill Bergiadis, Founder/CEO, Troy Acoustics, Personal Communications, October 2, 2023.

biochar for stormwater filtration and mine reclamation is being conducted by Caltrans and the California Department of Conservation.[141]

Designers and Builders in California

It is notable that there is significant capacity in California for designing and building mass timber projects. As indicated in Section 1 of this report, as of October 2024, there were 69 California projects described on the WoodWorks website. For many of these, the architects, structural engineers, and builders are identified. Although in some cases the required expertise was provided by out-of-state firms, most of the projects were designed and built by firms located within California. There were instances where specific expertise in mass timber construction was imported from out of State (e.g., from Washington and Oregon). For example, as previously noted, Swinerton/TimberLab and Western Wood Structures were involved in some projects.

According to the WoodWorks website, of the 69 projects listed, there were 37 different California architecture firms involved in mass timber building design. These include firms with national or international offices such as Skidmore, Owings and Merrill, and Perkins Eastman as well as local firms such as Aedis (member of TimberQuest).

There were 20 different structural engineering firms involved with the 69 projects. John A. Martin Associates is named as the engineer in several projects. Over 15 different builders constructed the projects, but four identified themselves as specialists in mass timber construction (e.g., Tomahawk Builders, W.S. Klem, Elevated Construction Services, and WEBCOR). Some projects retained specialists in building code compliance, presumably to ensure projects adhered to mass timber construction requirements.

Interviews with architects and designers indicated that those involved with mass timber construction favor its use because of its reduced embodied carbon as compared to steel and concrete, attractiveness and "biophilic" properties,[142] and costs that are comparable to alternatives. Some cited ease of construction with prefabricated structural members as compared to construction with steel and concrete. Interviewees and several company websites express a commitment to net zero carbon buildings. One company was favorably impressed by the State's new requirements for reduced embodied carbon in buildings.

With one exception, no construction issues with mass timber were reported. The one instance involved requiring temporary stabilization because of a specific design approach that slowed the erection and contributed to increased costs. Some interviewees cited benefits of mass timber construction, including lighter weight of structural elements, less concrete required in foundations, less noise during construction, less waste, and faster construction. Troy Acoustics stated that restrictions on allowing an out-of-state company to install wood wool cement panels for an end user may require hiring a local contractor (who may have no experience with this type of installation).[143]

[141] Elizabeth Betancourt, Natural and Working Lands policy Advisor, California Department of Conservation, Personal Communication, April 2024.
[142] Biophilic design is a concept used within the building industry to increase occupant connectivity to the natural environment through use of natural materials such as wood and through spatial design attributes.
[143] Bill Bergiadis, Founder/CEO, Troy Acoustics, Personal Communication, October 2, 2023.

With the exceptions noted below regarding continuous monitoring of custom glulam and CLT production and required reinforcement of CLT shear walls, no building code issues were mentioned by designers or builders. In fact, in one case, steel connectors needed to be encased with wood to protect them during a fire. This requirement acknowledged that the charring properties of mass timber provide superior protection during a fire.[144] Connectors are a key design element because of the complex set of requirements pertaining to loading, displacement, tolerance, and fire protection coupled with the availability, cost, and flexibility of pre-engineered and custom fabricated connection technologies. Regarding wood fiber cement panels, two design firms indicated that they have extensively used them because of their natural, stone-like appearance and/or ease of installation.

Designers and builders in California have utilized mass timber supplied by several of the companies previously listed. The main criteria used to select a vendor included production capacity and ability to deliver on time and on budget. Some of their clients required that material used for manufacturing mass timber be sourced from Forest Stewardship Council-certified forestry operations. Designers and builders prefer "package" solutions that include mass timber, connectors, and shop drawings all from the same source.

Obstacles to Doing Business in California

Cost of Innovative Wood Products

The cost of IWPs, specifically mass timber and wood wool cement panels, may exceed the cost of more conventional construction materials due to the location of suppliers outside of California. For example, Troy Acoustics reported that trucking costs for delivery to California from their Georgia operations have gone up exponentially compared to other states. Although the technical expertise for IWP use in California is robust, absence of suppliers and the need to import supplies may influence the number of projects implemented. Nevertheless, some interviewees stated that building with mass timber is cost competitive with other materials even with relatively high transportation costs. The perception of greater cost, real or not, may influence the choice of materials made by a State agency (see comment by CAL FIRE representative in Section 3 of this report).

Review and Approval Process

The outlook for marketing mass timber in Los Angeles was recently improved by the removal of the requirement for certification of building materials by the Los Angeles Department of Building and Safety (LARR certification) and acceptance of certification by the ICC Evaluation Service.[145] Regarding doing business with State agencies, one vendor considered the review and approval process by DSA to be a duplication of the requirements of local building officials. That review only applies to projects within DSA's authorities (listed below). None of the vendors or designers expressed any specific difficulties working with the few State projects they were involved with except for the requirement for continuous monitoring of CLT and glulam. As previously discussed (see Section 2, under DSA), California requires continuous, on-site monitoring of CLT and glulam manufacturing at the factory by an inspector approved by DSA or the Office of Statewide Health

[144] https://www.woodworkingnetwork.com/news/canadian-news/new-research-confirms-mass-timbers-fire-safety-taller-buildings

[145] https://www.drjcertification.org/content/7/los-angeles-changes-larr-process-isoiec-17065-accredited-process

Planning and Development before acceptance as an allowable building material for many State-sponsored projects.[146] This is considered a significant barrier to wider use of mass timber for State projects since there are only a few people certified to conduct the inspections and the manufacturing facilities are all located outside California. This essentially makes it largely infeasible to use European mass timber products and difficult to use mass timber from other States in such projects. At best, the requirement has caused supply chain delays.[147]

According to TimberQuest, another building code-related issue is the requirement for plywood reinforcement of CLT shear walls, which increases the cost of construction.[148]

The CBC's unique limits applied to tall wood building construction types are also impacting the cost of mass timber projects. A building's occupancy and construction type indicate its cost per square foot as can be seen in the ICC's latest Building Valuation Data.[149] As buildings get taller and larger (moving from Type V to Type I construction types) the fire and life safety requirements increase and make a large contribution to overall project costs. California enforces two unique provisions that dramatically reduce the size of Type IVA/B/C buildings, especially for housing applications resulting in applications that are 20 feet and one story shorter or more than 75 percent smaller. This means that an 85-foot tall, eight-story mid-rise building that can be built in neighboring states as a Type IVC would have to be built as a Type IVB in California with resulting increased regulatory requirements and cost.

State Agency Selection Process

Vendors did not identify any other specific obstacles to doing business in California. However, it should be noted that the issue of cost and local supply sources affects State agency choices of building materials. When costs for IWPs are compared to costs of conventional materials readily available within the State, an agency architect may be compelled to select what appears to be the least cost alternative. Also, the provisions of "Buy California" policies may affect choices. This is unfortunate if the IWP has superior attributes in terms of the State's GHG, embodied carbon, and forest restoration objectives.

The Canadian Wood Council commissioned the Athena Sustainable Materials Institute to compare the environmental impact of wood, steel, and concrete structures.[150] Athena is a non-profit organization that specializes in LCAs of construction projects. The sample building that was analyzed was a 2,300 square foot single family home constructed with typical Canadian construction practices. The result of their study is summarized in Table 4.

[146] Title 24, California Code of Regulations, Sections 1701.A.1.1., 1705A.5.5. and 1705.5.5
[147] Matt Larson, Preconstruction Director, XL Construction (TimberQuest partner), Personal Communications, February 2024
[148] Ibid.
[149] https://cdn-www-v2.iccsafe.org/wp-content/uploads/BVD-BSJ-FEB2024.pdf
[150] https://www.ecohome.net/guides/1010/how-wood-structures-compare-to-steel-and-concrete/

Table 4. Environmental Impacts of Metal and Concrete Construction Compared to Wood

Environmental Impact Compared to Wood	Embodied Energy	Negative Climate Impact	Negative Impact on Air Quality	Negative Impact on Water	Resources Consumed by Weight	Waste Produced
Metal	+53%	+23%	+74%	+247%	+14%	-21%
Concrete	+120%	+50%	+115%	+114%	+93%	+37%

The Athena study found that construction with wood in this scenario has far less negative carbon impacts than construction with steel or concrete. Another five-phase study initiated by The Nature Conservancy cites studies that indicate substituting mass timber for steel and concrete in mid-rise buildings (5-10 stories) can reduce emissions associated with manufacturing, transporting, and installing building materials by 13-26 percent.[151] In addition, wood sourced from sustainably managed forests may have other environmental and climate benefits. With California's emphasis on reducing embodied carbon in new construction, the role of LCAs will increase in the future for both practical and regulatory reasons. This emphasis alone should influence choices regarding construction material selection made by State agencies in the future.

SECTION 4: RECOMMENDATIONS AND IMPLEMENTATION

To recap, obstacles to increased use of IWPs in State sponsored or funded construction and maintenance projects include:

- Lack of consideration of the carbon benefits of IWPs as compared to other materials when State agencies choose materials for construction and maintenance projects. This could be due at least in part to lack of knowledge of these benefits by State agency staff.
- Perceptions of higher costs relative to conventional materials.
- Lack of IWP suppliers in the State may affect cost and ability for State agencies to procure IWPs.
- Regulatory constraints such as the requirement for continuous monitoring of custom glulam and CLT production for some State projects.
- Lack of research findings supporting use of IWPs such as biochar and biochar- or CNC-infused cement or biochar-infused asphalt.
- Lack of procurement procedures based on consistency with State policies, EOs, and legislation advocating reduced GHG and embodied carbon.

Some of these obstacles may be changed by CARB's efforts to implement AB 2446. The AIA continuing education requirement for courses in net zero carbon design for California architects, may also increase State designers' knowledge of IWPs.

In view of existing obstacles to increased use of IWPs, the following recommendations are offered for consideration:

[151] https://repositorio.uchile.cl/bitstream/handle/2250/189557/What_is_the_impact.pdf

1. **State agency designers and decision makers** at all agencies involved with procurement should account for the carbon benefits of IWPs in their procurement decisions to be consistent with policies advocating reduced embodied carbon in buildings and net zero GHG emissions in the future.

2. **CAL FIRE and Caltrans** should support continued research into IWPs through policy and financial incentives.

3. **State agency designers and decision makers** should be required to become better informed about the benefits and uses and IWPs through continuing education offerings by the Wood Institute, WoodWorks, American Institute of Architects (AIA) Los Angeles, the U.S. Green Building Council, the American Society of Civil Engineers, or other professionally recognized organizations.

4. **SGC, CEC, and HCD** should consider the use of IWPs in projects funded by their competitive grant programs. This should also apply to housing designed pursuant to Executive Order N-06-19.

5. **CBSC** should modify provisions of the CBC that impair use of IWPs in State projects, specifically the requirement for continuous monitoring for CLT and glulam production for DSA and Office of Statewide Health Planning and Development projects as well as other restrictions requiring height and area limitations applicable to mass timber buildings. Consideration should also be given to addressing restrictions regarding use of other IWPs, such as wood fiber insulation.

6. **The Joint Institute** should spearhead an effort to create a collaborative of State and federal agencies, educational and research institutions, and the private sector that will work to further the understanding and use of IWPs in both the public and private sectors. This collaborative should strive to establish information sharing procedures with agencies in other states and internationally, as appropriate.

7. **GO-Biz and LCI** should provide financial and regulatory incentives for the establishment of IWP manufacturers in California that will source raw material from California forest management and restoration projects.

8. **The Joint Institute** should create a staff position dedicated to monitoring State agency trends regarding procurement of IWPs for State projects. Policies and procedures should be evaluated in status reports prepared by the Joint Institute at five-year-intervals.

9. **The Governor** should issue an Executive Order (EO) implementing these recommendations.

The timeframe for implementing these recommendations will vary. Immediate implementation after issuance of an EO would occur for some (e.g., numbers 1, 2, and 3). Others such as numbers 4 and 5 will occur during regulatory and departmental review cycles that may extend over two or more

years. Full implementation, including the adoption of IWPs based on research findings and establishment of IWP producers in the State may take a decade or more.

JOINT INSTITUTE RECOMMENDATIONS TO EXPAND WOOD AND BIOMASS UTILIZATION IN CALIFORNIA

In 2020, the Joint Institute published a compendium of recommendations[152] aimed at increasing the utilization of wood and biomass sourced from California forests. The recommendations were proposed in light of State objectives to increase the pace and scale of forest restoration to reduce wildfire risk and improve the resiliency of forests in the face of climate change and other stressors. Several of the recommendations relate to IWPs. These are presented below, categorized by topic. The relationships between these recommendations and the recommendations in this report are briefly described.

Attract Innovative Wood Product Producers to the State

Recommendations:

- Provide financial incentives, leveraging public dollars to attract private capital to support demand for innovative wood and biomass products markets.
- Identify priority wood products manufacturing centers in or near forested communities throughout the State, based on the New Markets Tax Credits (NMTC), Opportunity Zones, locations that reduce transport costs, proximity to solid infrastructure (roads, highways, ports, etc.), and brownfields incentives.
- Provide grants to support workforce development.
- Identify and harmonize cross-jurisdictional regulatory and permitting requirements for wood and biomass infrastructure.
- Expand and clarify Sales Tax Exemption for wood products manufacturing, equipment, and products under the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA).
- Determine if biochar (made from forest biomass or other organic waste feedstocks) can qualify for the CAEATFA sales and use tax exemption either under "recycled feedstock" or "advanced manufacturing."
- Encourage private activity bonds, green bonds, and other relevant tax-exempt finance structures for large-scale wood utilization infrastructure finance.
- Achieve efficient and effective permitting for wood products facilities.
- Develop a handbook to assist local governments serving as lead permitting agencies.
- Engage university research and private entities to develop publicly available tools to improve feasibility analysis for proposed projects.
- Develop marketing, financial analysis, analytics, and tools that encourage investment in IWPs.

[152] https://bof.fire.ca.gov/media/31nfixsv/final-board-approved-joint-institute-wood-and-biomass-utilization-recommendations-_11-4-20_ada.pdf

- Signal California's interest in expanding wood products markets through State energy, climate, and procurement policies.

Relationship to Recommendations in this Report

All of these recommendations would be considered specific measures for incentivizing the establishment of IWP producers in the State.

Encourage Adoption of Innovative Wood Products by State Agencies

Recommendations

- Encourage coordination among agencies delivering funding or conducting procurement or relevant regulatory activities to enhance overall outcomes of State investments.
- Adopt State purchasing requirements for mass timber, CNC and biochar-infused cement and asphalt, and other IWPs for State facilities and operations.
- Implement a Statewide program in partnership with conservation groups, Registered Professional Foresters, Licensed Timber Operators, forest market leaders, and State and federal agencies.

Relationship to Recommendations in this Report:

This report recommends creating a collaborative work group to promote IWPs that aligns with the last recommendation of the Joint Institute report cited above. This report also includes a process for incorporating consideration of IWPs, focused on mass timber, into material procurement procedures (see Section 5). At the present time, IWPs other than mass timber, are not available in commercial quantities within the State or have not been approved for use in State projects.

SECTION 5: PROCESS FOR INCORPORATING CONSIDERATION OF INNOVATIVE WOOD PRODUCTS IN STATE PURCHASING

The previous sections of this report address State agency procurement procedures for construction and maintenance projects. Key findings in this report that inform recommendations to advance IWPs use by State agencies are:

- State agencies do not have published procurement protocols.
- Project materials are chosen by State agency designers and managers who may not be familiar with IWPs and who are left to interpret State policies regarding acceptable materials.
- IWPs have been used in few State projects.
- A survey conducted by DGS found that 80 percent of their 150 designers and managers had not considered the use of IWPs in projects they designed or approved. That same survey indicated that IWPs had only been used in eight projects overseen by DGS.

Based on these findings, a series of recommendations are presented in Section 4 of this report. The following process assumes that an EO requiring implementation of these recommendations will be issued by the Governor's Office. At the core of the following process is the belief that State

materials procurement procedures should be aligned with the many State policies regarding reduced emissions in the sourcing, production, construction, and other applications of materials used for State construction and maintenance activities.

RECOMMENDED PROCESS

California has made changes to the CBC that expand opportunities for use of mass timber for residential, commercial, and institutional construction projects (See Section 1 of this report.). Research and experimentation are underway at Caltrans and academic institutions to evaluate the potential use of other IWPs as substitutes for materials with greater levels of embodied carbon. Some IWPs, such as wood fiber insulation and wood wool cement panels are available and have been adopted for use by the private sector in California to various degrees depending on availability. It is anticipated that in the future, IWPs will play an increasingly important role in achieving the State's goals for creating a net zero carbon future.

Although it is acknowledged that mass timber is currently the most available and widely used IWP in California, the process presented below is designed to accommodate consideration of other IWPs in decision making on State construction and maintenance projects.

Role of LCAs

CARB is expected to develop its regulations for implementing AB 2446 by July 1, 2025. AB 2446 proposes a 40 percent reduction in GHG emissions of new buildings by 2035. It is anticipated that one of the fundamental requirements of those regulations will be to conduct an LCA of alternative building materials quantifying embodied carbon associated with raw material sourcing, production, transportation, and eventual disposal. Published LCAs comparing mass timber (or any wood product) to cement and steel for construction indicate lower embodied carbon associated with utilization of wood products. Although the focus of AB 2446 is on buildings, LCAs can be applied to any construction or maintenance project in which alternative materials are compared for relative GHG emissions. For example, in evaluating alternatives for sound wall construction, the life cycles of wood wool cement panels versus conventional concrete block walls could be compared to assess the embodied carbon of each product. Procedures for LCAs of alternative paving materials have been published.[153]

A critical part of a purchasing procedure considering IWPs would be to conduct an LCA for like materials being assessed for project use. Techniques for evaluating building materials are well developed, and there are several methods available that require relatively limited expertise.[154] These include procurement methods that are commercially available for use by architects and engineers. The front end of any State agency design and procurement process should be an LCA, utilizing existing, peer-reviewed LCA software. Note that in the case of buildings, they will often include both wood and other materials such as cement and steel. These "hybrid" buildings will require specific LCAs. During the process of conducting such analyses, options for substituting other IWPs such as wood wool cement panels, wood fiber cement panels, or wood fiber insulation for materials with higher levels of embodied carbon can be evaluated and optimal designs can be developed.

[153] https://www.fhwa.dot.gov/pavement/sustainability/hif15001.pdf
[154] https://sftool.gov/plan/403/life-cycle-assessment-buildings

Material Availability

Biochar and CNC-infused asphalt and cement currently have limited availability in California. Wood fiber cement panels are commercially available in quantity. There are vendors of wood fiber insulation and wood wool cement panels in the U.S. and overseas. Although there are no producers of mass timber in California, the sheer number of mass timber projects in the State (300 in design or built as of October 2024) indicate material is readily available.

Private sector designers employing mass timber for their projects report that the criteria they use for selecting a vendor includes production capacity and ability to deliver on time and on budget. Some indicated that vendors who source their materials from suppliers who are certified by the Forest Stewardship Council or Sustainable Forestry Initiative confirming sustainable forestry practices were favored. Until California has mass timber producers that can work at scale within the State, materials will be acquired from out of state or even outside the U.S. For other IWPs such as wood wool cement panels and wood fiber insulation, costs for procurement may affect their use even if LCAs indicate superior performance.

For those IWPs currently being evaluated for potential use, availability will depend not only on sources, but on acceptance for use by the agencies that will utilize those materials (e.g., Caltrans use of biochar-infused cement). Assuming mass timber and hybrid designs pass the LCA phase for State buildings or buildings subject to State approval, State designers should seek competitive offers from suppliers that can be evaluated and compared. Evaluation criteria should include documented product performance, environmental performance of the manufacturer and raw material supplier, ability to deliver on time and within budget, customer reviews, and cost. CARB has raised the issue of supply sourcing potentially impacting the carbon benefits of IWPs, especially mass timber. Ideally, the source of fiber for IWPs should be derived from forest restoration and fire prevention projects in California. Until there are IWP production facilities within the State, that will not be the case. To ensure that materials are sourced from sustainably managed forests, decisions on choice of products should include consideration of the chain of custody and as noted above, environmental performance of raw material suppliers. All things considered, the best value should be chosen as the next phase of decision making, keeping in mind that the best value may not be the cheapest alternative when carbon benefits and State climate goals are taken into consideration. Through State investment in IWPs, California can send a market signal, encouraging future establishment of IWP-related industries in the State, which will help reduce material costs and promote IWPs use more widely in the market, further supporting State climate goals.

Availability of Design and Construction Expertise

State agencies lacking mass timber design and build expertise should consult with California firms that have mass timber design and construction experience. For design-build projects, the use of IWPs should be a favored element in the scoping phase of the design-build process. As noted in Section 3 of this report, there are many in-state designers, engineers, and firms that specialize in mass timber construction. The next step in the procurement process will likely include the selection of design and construction professionals. Conducting a design competition for State buildings as was done in 2020 for private sector buildings by the Governor's Forest Management Task Force and LCI could be incorporated into the initial phase of implementing purchasing procedures. It is expected that when other IWPs, such as alternative paving materials become acceptable for use, that State agency personnel will possess the expertise needed to use those materials.

Final Selection

The final selection of a project design would be based on the findings of the LCA, choice of the product supplier, and, if appropriate, choosing design and construction contractors.

IMPLEMENTATION PROCESS AND TIMEFRAME

Implementing the recommendations provided in Section 4 of this report would set the stage for adoption of the process outlined above by State agencies. An EO focused on promoting IWPs use, as suggested in Section 4, could help elicit a rapid response by agencies. It is likely that when CARB issues its framework for implementing AB 2446, that conducting LCAs for buildings to confirm carbon benefits will be mandatory.

For now, it is strongly recommended that State designers and engineers become better educated about the applications and appropriate, approved uses of IWPs as well as how these products can help the State achieve its climate goals. This up-front commitment will allow IWPs procurement to commence immediately once policies are in place, supporting the State's transition to a net zero emissions economy.

CONCLUSIONS

Summarized below are key conclusions from this investigation:

- There are several IWPs that have potential for reducing GHG emissions and helping the State meet its goal for a net zero emissions future if they were used for State construction and maintenance projects. Some (mass timber and wood fiber cement panels) are widely used for private sector projects. Others have limited availability (wood fiber insulation and wood wool cement panels) or are currently undergoing testing and experimentation regarding their potential use.
- Although there are regulations, policies, EOs, and legislation advocating reduced GHGs and embodied carbon in buildings, these objectives are not reflected in State agency purchasing procedures regarding selection of construction or maintenance materials.
- State agency designers, engineers, and decision makers may not be fully aware of the benefits of IWPs when they choose construction and maintenance materials.
- There are many architects, engineers, and builders in California that have experience with mass timber construction. California's private sector has adopted the use of mass timber for many projects based on its reduced GHG emissions compared to other materials, its attractiveness, and other factors. Mass timber products are imported into the State from other states or Europe.
- Regulations that will require LCAs for alternative building designs focused on embodied carbon will be forthcoming in the next few years. It is expected that IWPs will play an increasingly important role in the future as a pathway to meeting California's zero emissions targets.

Appendix A. Key Contacts and Website List

Policy Context for Increased Utilization of IWPs by California State Agencies
Contacts and Websites

Websites and individuals contacted during the preparation of this report are listed below. Note that in the case of other states and nations, except for Oregon, no government representative was identified as a principal contact. Because of this, information about their policies regarding IWPs was obtained exclusively from publicly available documents. Representatives of California state agencies were contacted as part of the Scope of Work Task 3 efforts.

Personal Contacts

Greg Stangl, Phoenix Energy Company, stangl@phoenixenergy.net, (415) 286-7822
Tom Miles, TR Miles Technical Consultants, tmiles@trmiles.com, (503)780-8185
Bill Bergiadis, Troy Acoustics Inc., Bill.Bergiadis@troyacoustics.com, (818) 376-8491
Marcus Kaufmann, Oregon Department of Forestry, Marcus.Kaufmann@odf.oregon.gov, (541) 580-7480
Martin Twer, The Watershed Center, martin@thewatershedcenter.com, (406) 207-1756
Chelsea Drenick, WoodWorks, chelsea.drenick@woodworks.org, (303) 588-1300
Matt Larson, XL Construction (TimberQuest), MLarson@xlconstruction.com. (408) 834-3558
Mae Kawamoto, Daedalus Engineering (TimberQuest), mkawamoto@daedalus-eng.com, (510) 427-8713

California Policy

AB 2446: https://legiscan.com/CA/text/AB2446/id/2607014
DGS Buy Clean California Act: https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act
CARB, Embodied Carbon: https://ww2.arb.ca.gov/our-work/programs/embodied-carbon/about
California Green Sustainability Roadmaps: https://green.ca.gov/home/roadmaps
DGS, Environmentally Preferable Purchasing: https://www.dgs.ca.gov/PD/Resources/Find-EPP-Goods-and-Services
DGS, CALGreen: https://www.dgs.ca.gov/BSC/CALGreen

Policies of Other States/Nations

Washington Biochar Stormwater Filtration:
https://apps.ecology.wa.gov/publications/documents/2110023.pdf
Washington Mass Timber Policy: https://app.leg.wa.gov/rcw/default.aspx?cite=19.27.570
University of Washington Green Building Standards:
https://sustainability.uw.edu/campus/buildings/green-building-standards
British Columbia Wood First Initiative: https://www.bcfii.ca/our-funding-programs/wood-first/
Oregon Mass Timber Coalition: https://www.masstimbercoalition.org/
Washington Preferential Tax Policy: https://dor.wa.gov/sites/default/files/2022-02/sn_19_TimberActivitiesExpanded.pdf
Wood Works British Columbia: https://wood-works.ca/bc/

Wood Works Innovation Network: https://www.woodworksinnovationnetwork.org/en-ca/
U.S. Department of Agriculture BioPreferred Program: https://www.biopreferred.gov/BioPreferred/
European Mass Timber: https://www.architecturalrecord.com/articles/16292
European Biochar Market: https://www.marketdataforecast.com/market-reports/europe-biochar-market
U.S. Army Corps of Engineers Mass Timber Mandate: https://www.enr.com/articles/57469

Mass Timber

San Mateo Office Building 3: https://www.som.com/projects/san-mateo-county-office-building-3/
Sonrisa: https://www.sonrisadowntown.com/sustainability
TimberQuest: https://timber-quest.com/
United Kingdom Timber Projects: https://waughthistleton.com/100-projects-uk-clt/
Mapping Mass Timber: https://www.woodworks.org/wp-content/uploads/WoodWorks-Mass-Timber-Projects-Sept-2024.png
Arch Daily Architecture Platform, CLT: https://www.archdaily.com/1006603/cross-laminated-timber-reaches-new-heights-why-use-clt-in-construction
Arch Daily Architecture Platform, Mass Timber Skyscrapers: https://www.archdaily.com/1006779/timber-skyscrapers-a-low-carbon-typology-for-the-21st-century

Biochar

Scholarly Community Encyclopedia, Biochar: https://encyclopedia.pub/entry/23954
The Biochar Journal, 55 Uses of Biochar: https://www.biochar-journal.org/en/ct/2
Sonoma Biochar Initiative: https://sonomabiocharinitiative.org/
Wilson Biochar: https://wilsonbiochar.com/
Biochar Zero, Biochar in Asphalt: https://biochar-zero.com/construction-industry/biochar-in-asphalt/
Biochar Soil Amendment: https://www.nrcs.usda.gov/sites/default/files/2022-11/336-NHCP-CPS-Soil-Carbon-Amendment-2022.pdf
Oregon Biochar Solutions, Biochar Pricing: https://www.chardirect.com/rogue-biochar-pricing
Chemosphere Biochar Technology in Wastewater Treatment: A Critical Review: https://www.sciencedirect.com/science/article/abs/pii/S0045653520307323
U.S. Department of Agriculture Climate Hubs, Biochar Information: https://www.climatehubs.usda.gov/hubs/northwest/topic/biocharBiofuels, Biorefining, and Bioproducts, Market Prospects for Biochar Production and Application in California: https://onlinelibrary.wiley.com/doi/10.1002/bbb.2280?af=R

CNC-/Biochar-Infused Cement

Interesting Engineering, This Eco-Friendly Concrete Uses Biochar to Suck Out Carbon Dioxide: https://interestingengineering.com/innovation/eco-friendly-concrete-biochar-carbon-dioxide
CNC Concrete: https://www.forestdatanetwork.com/news/learning-about-nanocellulose-and-concrete
Purdue University, Purdue Researchers Show Concrete Infused with Wood Nanocrystals is Stronger, Plan to Use it in California Bridge: https://www.purdue.edu/newsroom/releases/2018/Q1/purdue-researchers-show-concrete-infused-with-wood-nanocrystals-is-stronger,-plan-to-use-it-in-california-bridge.html

U.S. Forest Service, Bridging the Gap: Concrete May Provide New Market Opportunities for Forest Materials: https://www.fs.usda.gov/inside-fs/delivering-mission/deliver/bridging-gap-concrete-may-provide-new-market-opportunities
Biochar Zero, Biochar in Concrete and Cement: https://biochar-zero.com/construction-industry/biochar-in-concrete/#:~:text=Biochar%20intended%20for%20usage%20in%20a%20concrete%20product,This%20ensures%20basic%20requirements%20for%20the%20biochar%207

Wood Fiber Insulation

Building Matters, In Favor of Wood Fiber Insulation: https://www.finehomebuilding.com/project-guides/insulation/284-in-favor-of-wood-fiber-insulation
TimberHP Wood Fiber Insultation: https://www.timberhp.com/
Accesswire, New Energy Works Receives the First Shipment of Wood Fiber Insulation Made in the United States: https://www.accesswire.com/777705/new-energy-works-receives-the-first-shipment-of-wood-fiber-insulation-made-in-the-united-states

Bio Asphalt

Biochar Zero, Biochar in Asphalt: https://biochar-zero.com/construction-industry/biochar-in-asphalt
Arizona State University, New Asphalt Binder Alternative is Less Toxic, More Sustainable Than Conventional Blend: https://news.asu.edu/20230918-solutions-new-asphalt-binder-alternative-less-toxic-more-sustainable-conventional-blend

Carbon Credits/Certification

Carbon Future: https://www.carbonfuture.earth/
Verra: https://verra.org/programs/verified-carbon-standard/
Aureus Earth: https://www.aureusearth.com/

Appendix B. Board of Forestry Letter of Introduction

STATE OF CALIFORNIA
GAVIN NEWSOM, *Governor*

BOARD OF FORESTRY AND FIRE PROTECTION
J. Keith Gilless, Chair

THE NATURAL RESOURCES AGENCY
WADE CROWFOOT, *Secretary*

P.O. Box 944246
SACRAMENTO, CA 94244-2460
(916) 902-9739
Website: www.bof.fire.cagov

November 30, 2023

Dear Agency Contact

Dear Contact:

The Board of Forestry and Fire Protection's Joint Institute for Wood Products Innovation (Institute) is assessing current state protocols looking for pathways to facilitate procurement of innovative wood products (IWP) by State agencies for their construction and maintenance projects. To help inform this effort, we are requesting information from State agencies regarding their design and purchasing protocols as they relate to IWP. The Institute has retained TSS Consultants (TSS) to conduct this research.

In recent years, the forest products sector has produced groundbreaking products, such as:

- Mass timber (used in residential, institutional and commercial buildings)
- Cellulosic nanocrystals (used in cement to cut carbon emission production by up to 20%)
- Wood wool cement panels (lighter, more sound absorption)
- Wood fiber insulation (used in residential and commercial buildings)
- Biochar (enhanced soil amendment and water filtration medium)

To realize the societal and environmental benefits of these products, we are requesting information from you as to whether or not your department regularly incorporates IWP in your design of buildings or purchase of construction and maintenance materials or if your department could do so if design protocols or marketplace changes were made. In particular, we are requesting the following information:

- Published department procedures for considering IWP materials during the design and/or maintenance phases of your projects.
- Document testing and/or certification methods used to determine if new materials are acceptable for use in agency projects.
- Any concerns/perceived barriers associated with procedures for adopting new products. Describe any concerns regarding the use of IWP in building design, construction, or maintenance activities.
- Any suggestions for improving the potential for use of IWP in projects.

We appreciate your time and consideration and welcome any assistance you can provide to help support this project. Please contact Patrick Nevis at (916) 803-8639 or pnevis121@icloud.com to discuss this further.

Sincerely,

J. Keith Gilless
Board of Forestry and Fire Protection Chair
Joint Institute for Wood Products Innovation Co-Chair