

POLICY CONTEXT FOR INCREASED UTILIZATION OF INNOVATIVE WOOD PRODUCTS BY CALIFORNIA STATE AGENCIES

Prepared for:



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EXECUTIVE SUMMARY

TSS Consultants (TSS) has been retained by the California Joint Institute for Wood Products Innovation to conduct an assessment of state purchasing protocols specifically related to deployment of innovative wood products (IWP). One of the initial assessment tasks was crafted with the intention to obtain and review purchasing protocols of other states (and possibly Canadian provinces) to determine to what extent they recognize and promote the procurement of IWP by their respective governmental agencies. What we found was that rather than purchasing protocols, there are initiatives, programs and legislation that promote innovative wood products, particularly biochar and mass timber. After searching for purchasing protocols of California state agencies, we found essentially the same thing. California has adopted several key policies and instituted programs that could directly or indirectly support the use of innovative wood products in agency-funded construction and maintenance activities. These include executive orders and legislation as well as mandates such as requirements for LEED certification of public buildings and meeting “sustainability guidelines.” Consequently, this report describes these policies in California and other entities because they are key directives that shape the actions of bureaucratic agencies.

In addition to the assessment of policy, this report provides succinct descriptions of IWP examples with emphasis on California. If California examples are not available, some from other states are cited. In some cases, California agencies are currently experimenting with the use of innovative wood products and those are described if relevant.

STATE OF CALIFORNIA INITIATIVES AND POLICIES

Support for deployment of innovative wood products within California ranges from executive orders issued by governors Brown and Newsom, to legislative mandates.

Executive Orders

There are four key executive orders (EO) that relate to state goals to reduce greenhouse gas emissions associated with construction and maintenance projects.

Executive Order B-18-12

EO B-18-12 is considered seminal. This EO mandates that all new state buildings and major renovations be zero net 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).

Executive Order B-30-15

EO B-30-15 established the state-wide greenhouse gas 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 these targets. It also advises agencies to take climate change into account when making planning and investment decisions.

Executive Order B-55-18

EO B-55-18 proclaims the goal of achieving carbon neutrality no later than 2045 and to maintain net negative greenhouse gas emissions thereafter. It provides no details on construction or maintenance projects.

None of these EOs refer to the opportunities provided by incorporating innovative wood products 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 innovative wood products.

Executive Order N-04-19

EO N-04-19 was signed into law in January 2019. It proposes an alternative approach to state procurement based on “Requests for Innovative Ideas” for solving specific problems. Agencies can develop an “Innovation Procurement Sprint” asking for 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 conduct 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. This EO may facilitate proposals for adoption of innovative wood products if that were to become a priority to the state.

Executive Order N-06-19

EO N-06-19 was signed into law on January 15, 2019. It directed the Department of General Services (DGS) to create a digitized inventory of state-owned properties that are deemed surplus to agency needs. DGS was also charged with the responsibility of 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. DGS is now working with the Department of Housing and Community Development 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 executive orders and AB 2446 (discussed below), it may encourage increased use of innovative wood products.

Sonrisa studio apartments¹ 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 cross laminated timber on a concrete slab foundation, and it is the first of its kind in Sacramento. It is perhaps the precursor of additional future projects utilizing innovative wood products.

¹ <https://www.sonrisadowntown.com/sustainability>

Legislation and Code Changes

The legislation that is most relevant to the potential use of innovative wood products to help meet ambitious greenhouse gas emissions and carbon goals is Assembly Bill 2446, passed on September 16, 2022. It seeks to achieve a 40 percent reduction in the greenhouse gas emissions of new buildings by 2025. It proposes creating a framework for measuring and reducing the average carbon intensity i.e., “embodied carbon emissions” in residential projects of five or more units and non-residential construction of 10,000 square feet or more. It directs the California Air Resources Board (CARB) to create that framework. It furthermore advocates the evaluation of measures to support market demand and financial incentives to encourage production and uses of materials with low greenhouse gas intensity. Products must have an “Environmental Product Declaration” based on a life cycle assessment as compared to alternative construction materials. For example, 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 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.

The “Buy Clean California Act” (Public Contract Code Section 3500-3505) requires that several construction materials (structural steel, concrete reinforcing steel, flat glass, and mineral board insulation) meet mandated maximum “Global Warming Potential” limits. These limits would appear to be analogous to embodied carbon and are estimated over a 100-year timeframe. Although not directly relevant to innovative wood products, the limits set for these alternative construction materials might be used for comparative life cycle analysis.

On June 30, 2022, the California Building Standards Commission, the Division of the State Architect and the Department of Housing and Community Development 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 in 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. As of September 2023, the section on Material Conservation and Resource Efficiency had not been fully developed and there is no reference to mass timber or other innovative wood products.

The CALGreen Carbon Reduction Collaborative is continuing work on embodied carbon, whole building life cycle assessment and zero net carbon design. The California American Institute of Architects, a founding member of the collaborative, has successfully instituted a continuing education requirement in designing buildings that minimize greenhouse gas emissions for California’s licensed architects. 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 changes to the building code that will limit embodied carbon emissions in commercial and school buildings. The change is an amendment to the 2022 California Green

Building Standards Code (CALGreen),² California's statewide green building code that was developed to supplement the general code in 2007. 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 code will limit embodied carbon emissions for commercial buildings larger than 100,000 square feet and school buildings larger than 50,000 square feet.

As previously noted, CARB is charged with the responsibility of developing a 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 greenhouse gas emissions in building materials.³ It has recently released a request for proposals titled “Technical Feasibility, Cost-Effectiveness, and Policy Strategies for Reducing Embodied Carbon in Building Materials”. The results of this study will inform the Board’s implementation of AB 2446. Award of the contract is anticipated by Spring, 2024, and the study should be completed within 24 months thereafter.

State Agency Sustainability Roadmaps

In response to EOs and the sustainability goals of the governors, the Department of General Services, Office of Sustainability developed a “Sustainable Policy and Best Practices Manual”.⁴ This document, in turn, was used by that department and other state agencies to produce “Department Sustainability Roadmaps”.⁵ 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”⁶ that provides guidance on this does not address construction materials.

Although all the roadmaps and the DGS best practices manual contain a section on environmentally preferable purchasing, none of them address the potential role of innovative wood products that

² <https://www.dgs.ca.gov/BSC/CALGreen>

³ <https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-program/>

⁴ file:///Users/bernardmason/Downloads/CASPBPM.pdf

⁵ <https://green.ca.gov/home/roadmaps>

⁶ <https://www.dgs.ca.gov/PD/Resources/Find-EPP-Goods-and-Services>

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 the California Air Resources Board, CalTrans, CAL FIRE and the Department of Corrections (CDCR) were reviewed to ascertain if there were any references to innovative wood products 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 innovative wood products such as mass timber, wood fiber cement panels, or cement infused with biochar or nanocrystals to offset greenhouse gas emissions was considered.

The roadmap for CDCR refers to design and construction policy guidelines that outline requirements to consider and mitigate greenhouse gas 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.).”

This would seem to limit the likelihood that the agency would consider mass timber for its construction or renovation projects. However, it does not necessarily eliminate the potential for using wood wool cement panels or cement infused with biochar or nanocrystals.

The CalTrans roadmap states that its construction standard specifications include guidance on the composition of materials to be used in construction projects. The 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 innovative wood products such as biochar or nanocrystal infused cement, wood fiber cement panels (e.g., sound walls) or biochar (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.⁷

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

⁷ 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.

considerations are given to all building elements. It fails to state that innovative wood products will be considered in its future building plans.

California Procurement Policy Findings

In summary, there is an apparent vacuum in state policy on environmentally preferable purchasing regarding the role of innovative wood products in meeting carbon embodiment objectives and greenhouse gas emissions reductions. This vacuum exists despite the advocacy of CAL FIRE for use of these products as demonstrated by the existence of the Board of Forestry Joint Institute for Innovative Wood Products. This could possibly be remedied when CARB produces guidelines for implementing AB 2446 in three years. Also, EO N-06-19 in combination with other executive orders and AB 2446 may create a demand for using innovative wood products in sponsored affordable housing projects. This is of particular interest since it is a major focus of the Oregon Mass Timber Initiative, discussed below.

Consultation with the Department of General Services indicates that there is not a department purchasing protocol document encompassing direction from the legislature, executive orders, and internal Department policies. Individual designers or architects are on their own to interpret the legislation, executive orders, and policies in shaping their projects.

SUPPORT FOR IWP IN OTHER STATES AND NATIONS

Other states, nations, and Canadian provinces have promoted the use of innovative wood products. The mass timber construction industry is strongly supported by several European nations, and the number of mass timber buildings in Europe has increased steadily over the past decade. For example, as of 2018, there were at least 100 mass timber projects in England.⁸ Biochar is also an important market in Europe with 72 processors producing about 80,000 tons/year.⁹ Below is a brief description of support for mass timber and biochar in Oregon, Washington, and British Columbia. A cursory review did not disclose governmental support for other innovative wood products in Oregon, Washington, or British Columbia.

Oregon

The Oregon Mass Timber Initiative 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.¹⁰ This initiative highlights the relationship between forest restoration activities on National Forest managed forestland supplying timber to produce modular housing using mass timber. The Initiative 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

⁸ <https://waughthistleton.com/100-projects-uk-clt/>

⁹ Personal communication, Tom Miles, July 26, 2023.

¹⁰ <https://www.masstimmercoalition.org/>

modular housing that will be deployed to communities in need in 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 Initiative 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.

Washington

In 2022 the Washington State Legislature passed a bill requiring the consideration of biochar 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.¹¹ Washington passed a bill in 2018 requiring the development of building codes for the use of mass timber in residential and commercial building construction.¹² Subsequent changes to the building code allow mass timber structures as tall as 18 stories. As of 2023, there were over 160 mass timber structures built, under construction, or being designed in Washington.¹³ 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”¹⁴ and 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 producers of mass timber products.¹⁵

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 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.¹⁶ 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” website¹⁷ provides resources including design software, construction manuals, and an “e-learning” application for use by architects and builders. The Woodworks Innovation Network is “a professional online community that provides resources for design and construction professionals looking to incorporate sustainable wood

¹¹ <https://apps.ecology.wa.gov/publications/documents/2110023.pdf>

¹² <https://app.leg.wa.gov/rcw/default.aspx?cite=19.27.570>

¹³ <https://www.woodworks.org/wp-content/uploads/WoodWorks-Mass-Timber-Projects-June-2023.png>

¹⁴ <https://sustainability.uw.edu/campus/buildings/green-building-standards>

¹⁵ https://dor.wa.gov/sites/default/files/2022-02/sn_19_TimberActivitiesExpanded.pdf

¹⁶ <https://www.bcfii.ca/our-funding-programs/wood-first/>

¹⁷ <https://wood-works.ca/bc/>

products into their projects.”¹⁸ It operates across Canada and was made possible with funding from Woodworks U.S. and Natural Resources Canada.

U.S. Federal Policies in Support of Innovative Wood Products

Although not a primary focus of this review, it is of interest to note that there are at least two initiatives at the federal level that are supportive of innovative wood product utilization. These are in addition to the strong support that is provided by the U.S. Forest Service.¹⁹ 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. In fiscal year 2023, EQIP will reimburse farmers up to \$194.41 per cubic yard of biochar used as a soil amendment.²⁰ Current prices for biochar in California are much more than this but in Oregon, bulk biochar is available at between \$110 and \$120/cubic yard.²¹ With 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”.²² This program was created by the 2002 Farm Bill and reauthorized and expanded as part of the Agriculture Improvement Act of 2018. It requires mandatory product purchasing 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 innovative wood products 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 (SAM) website. The list of “success stories” on the Biobased Program website did not indicate any examples where innovative wood products were used in agency projects. In many respects, the Biobased Program is like California’s “Buy Clean Green” and “Buying Green Guide” for “Environmentally Preferable Purchasing.”

Summary of Support in Other Jurisdictions

Oregon and Washington are the two largest producers of softwood lumber and plywood in the U.S. Forest industry is the most important industry in British Columbia and it is one of the largest exporters of wood products in the world. It is only reasonable to expect that these jurisdictions would place emphasis on the promotion of innovative wood products that will incidentally play an increasing role in the achievement of reduced greenhouse gas emissions in the future. Economic incentives are not the primary incentive in California where the forest industry is a relatively small contributor to the state’s gross production. If California’s state agencies are to increase purchasing of innovative wood products, it will be driven by climate objectives.

¹⁸ <https://www.woodworksinnovationnetwork.org/en-ca/>

¹⁹ <https://www.fs.usda.gov/science-technology/energy-forest-products/wood-innovation>

²⁰ https://pacificbiochar.com/nrcs-soil-carbon-amendment-808-336_faqs/

²¹ <https://www.chardirect.com/rogue-biochar-pricing>

²² <https://www.biopreferred.gov/BioPreferred/>

INNOVATIVE WOOD PRODUCT EXAMPLES

In this section, examples of successful innovative wood product applications are briefly described. The coverage is not comprehensive; many examples could be provided for some of the products. The intent is just to provide some of the more accessible illustrations, with California cases, as available. The prime benefits of innovative wood products 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 to 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 availability.

Mass Timber

The number of mass timber construction projects in the United States and worldwide has increased dramatically over the past several years. As of June 2023, there were 1,860 multi-family, commercial or institutional mass timber projects in progress or built in the U.S.²³ That includes 275 projects in California which is far more than any other state.²⁴ The top five manufacturers of cross laminated timber are in Europe²⁵ but there are several companies producing mass timber structural products in Oregon, Washington, Canada, Montana, and Alabama. 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,²⁶ a company providing mass timber modular classrooms. To date, TimberQuest has built two mass timber schools for private clients: Sacred Heart School in Atherton (pictured below in Figure 1) and Stratford School in Pleasanton. They are currently (September 2023) designing a school 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.

²³ <https://www.woodworks.org/resources/mapping-mass-timber/>

²⁴ <https://www.woodworks.org/wp-content/uploads/WoodWorks-Mass-Timber-Projects-June-2023.png>

²⁵ <https://www.imarcgroup.com/top-cross-laminated-timber-manufacturers-worldwide>

²⁶ <https://timber-quest.com/>

Figure 1. Sacred Heart School, Atherton



The County of San Mateo is completing a 208,000 square foot government office building that is constructed of mass timber including wood columns, beams, and cross laminated timber floor decks. The county claims that it is the first net-zero energy design civic building in the United States. It will open in late 2023.²⁷ Figure 2 is an artist’s rendering of the county’s planned administration building interior.

Figure 2. San Mateo County Administration Building



²⁷ <https://www.smcgov.org/ceo/county-office-building-3>

As previously discussed, Sonrisa is the first residential project in Sacramento built with cross laminated timber. Cross laminated timber 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 generic term for fine-grained, highly porous charcoal-like material that is produced through acid pyrolysis. Depending on their qualities, biochar may be used as soil amendment, water filtration media or other purposes.²⁸ Wakefield Biochar²⁹ soil amendment (see Figure 4) is commercially available at outlets such as Home Depot and Lowes, selling for \$39 cubic/foot. As of 2012, there were 12 biochar producers in California.

²⁸ <https://www.biochar-journal.org/en/ct/2>

²⁹ Manufactured in Valdosta, Georgia.

Figure 4. Wakefield Biochar



The Sonoma Biochar Initiative is dedicated to promoting biochar education and its sustainable use throughout California.³⁰ It is supported by several Resource Conservation Districts, the International 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 emissions related to the use of Ring of Fire biochar kilns.³¹ 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. 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.³²

Cellulosic Nanocrystal and Biochar Infused Cement

Incorporating cellulosic nanocrystals produced by acid hydrolysis into cement has been demonstrated through research studies to increase its hydration and strength. The Moffett River bridge replacement in Siskiyou County was done with precast concrete beams using nanocellulose provided by the U.S. Forest Service, Forest Products Laboratory.³³ 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 cellulosic nanocrystals as an additive for cement. The environmental benefits of adding nanocrystals 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.

³⁰ <https://sonomabiocharinitiative.org/>

³¹ <https://wilsonbiochar.com/>

³² <https://www.sciencedirect.com/science/article/abs/pii/S0045653520307323>

³³ <https://www.fs.usda.gov/inside-fs/delivering-mission/deliver/bridging-gap-concrete-may-provide-new-market-opportunities>

Figure 5. Nanocrystal and Biochar Infused Cement Beams



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.³⁴ No examples of biochar concrete projects were identified in California.

Wood Fiber Cement Panels

Wood fiber cement panels have been produced and used for decades and are commonly used as a decorative sound-absorbing, construction, and insulation material. Important manufacturers are in China, Sweden, and the Netherlands. Troy Acoustics Corporation, located in Thomasville, Georgia, currently utilizes wood fiber cement panels for a variety of projects including highway noise barriers, recording studios, commercial offices, stadiums, arenas, and shooting ranges. Pictured below is one of their highway sound wall installations. 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 housing and commercial use. The Thomasville Payroll Authority granted 75 acres for the construction due to the projected employment of 88 workers.³⁵

³⁴ <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.>

³⁵ Personal communication, Bill Bergiadis, Troy Acoustics Corporation, October 1, 2023.

Troy currently obtains its wood wool cement panels from a manufacturing facility in 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.³⁶ 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



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,³⁷ an Italian company that also produces cement bonded particle board, is certified by the Forest Stewardship Council for utilizing sustainably managed wood in its production process. Timber HP, a company located in Maine,³⁸ is the first company in the United States 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 state and Oregon. No use of wood fiber insulation in California was discovered during the preparation of this report.

Biochar Asphalt

Asphalt covers 94% of paved roads in the U.S.³⁹ 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.⁴⁰ Advantages found to date include improved temperature resistance (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

³⁶ Personal communication, Bill Bergiadis, Troy Acoustics Corporation, October 2, 2023.

³⁷ <https://www.betonwood.com/>

³⁸ <https://www.timberhp.com/>

³⁹ Fiscal Year 2022 APPLICATION FORM, Wood Innovations Funding Program (CFDA 10.674) (accepted and funded in FY 2022)

⁴⁰ <https://biochar-zero.com/construction-industry/biochar-in-asphalt/>

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 study 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 implementation of innovative wood products in the state. It appears that mass timber projects are mainly in the private sector although at least one county and school district are employing the approach. To our knowledge, the Sonrisa project is the only example of a state agency sponsored mass timber project. 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 in 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 sequestered a large share of the market for that construction technique. Troy has had no experience with projects for California state agencies.

Other products are in limited supply or have not found wide acceptance. That may change in the future.

IWP CARBON CREDIT CERTIFICATION

There are three organizations that currently provide services to document and verify carbon removal credits associated with innovative wood products. An additional organization (Climate Action Reserve, discussed below) is in the process of developing a certification protocol for biochar. The California Air Resources Board manages the carbon offset compliance program for the state. Under that program, companies or other organizations that are compelled to reduce their greenhouse gas emissions can purchase offset credits on the compliance market. There are no approved protocols for quantifying carbon removal or sequestration effects of innovative wood products. Approved protocols only relate to livestock, mine methane, ozone depletion, rice cultivation and forests, including urban forests. As the markets and applications of innovative wood products increase over time, there will undoubtedly be more organizations that offer these services.

Climate Action Reserve

Climate Action Reserve, a major certifier of carbon credits for forests and grasslands in the United States and Canada, is currently developing a certification protocol for carbon removal by 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 greenhouse gas crediting program.⁴¹ 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 innovative wood products.

Aureus Earth

Aureus Earth is headquartered in Boulder, CO. The company's mission is to financially incentivize the most carbon efficient material decisions for construction.⁴² 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 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.⁴³ 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 an 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. Carbonfuture⁴⁴ 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 cross laminated timber are certified by the Forest Stewardship Council. These include D.R. Johnson, Kattera, Kalesnikoff, Nordic Structures, SmartLam North America, Structurlam Products and StructureCraft.⁴⁵ When coupled with the

⁴¹ <https://verra.org/programs/verified-carbon-standard/>

⁴² <https://www.aureusearth.com/>

⁴³ <https://puro.earth/>

⁴⁴ <https://www.carbonfuture.earth/>

⁴⁵ <https://www.buildwithfsc.org/post/>

potential for obtaining carbon offset credits for mass timber, certification for sustainable forestry is a powerful incentive for its increased acceptance in the marketplace.