NOYES LAW CORPORATION
FUEL & CARBON LAW

June 15, 2025

Liane Randolph
Chair
California Air Resources Board
Comment Submitted Electronically
RE: Proposed Repeal of the In-Use Locomotive Regulation

Dear Chair Randolph,

This letter sets forth Sierra Northern Railway's ("Sierra Northern") and Sierra Railroad Company's ("Sierra Railroad") comments in support of the California Air Resources Board's ("CARB") Proposed Repeal of the In-Use Locomotive Regulation (the "Proposed Repeal"). Sierra Northern and Sierra Railroad appreciate the opportunity to provide these comments to CARB (the "Comment").

I. Summary of Comment

For more than a decade, Sierra Northern has directly engaged with CARB staff and leadership to collaboratively develop and implement an industry-informed, cost-effective, and feasible strategy for reducing greenhouse gas ("GHG") and criteria pollutant emissions in the short line railroad industry. In a landmark achievement in March of this year, Sierra successfully completed testing of the first four-axle hydrogen-fueled, zero emission switching locomotive in the U.S. at Sierra's railyard in West Sacramento as further described and illustrated in **Exhibit A** of this Comment.[1]

Pre-Tier 0 Locomotive, Predominant Shortline Locomotive in California

The yellow train pictured above is a pre-Tier 0 diesel electric locomotive and is representative of most of the locomotives in California's short line fleets today. The blue train pictured on the following page is Sierra Northern's hydrogen switcher locomotive funded primarily through a $4,000,000 grant by the California Energy Commission ("CEC").

[1] Climate Insider, "First Hydrogen-Fueled Zero-Emission Locomotive in U.S. Tested in California," (April 9, 2025), available at https://climateinsider.com/2025/04/09/first-hydrogen-fueled-zero-emission-locomotive-in-u-s-tested-in-california/.

Hydrogen Locomotive Built in 2025 by Sierra Northern Using Modular Components Mounted upon a Tier 3 Railpower, Inc Genset Locomotive Chassis

In addition to CEC, the Sacramento Metropolitan Air Quality District, SoCalGas and the Low Carbon Resource Initiative are Sierra Northern's funding partners. GTI Energy, Velocity Strategies, Railpower Tech, WHA International, Inc., OptiFuel Systems, Ballard Power Systems, UC Riverside and Valley Vision are project partners.

This Comment expresses Sierra Northern's and Sierra Railroad's support for the Proposed Repeal. Most importantly, this Comment provides specific recommendations for how CARB can most rapidly and efficiently achieve its criteria pollutant and GHG pollutant reduction goals through the unlocking of state funds and the recognition of GHG emission reductions achieved by the utilization of forest waste collected in wildfire risk reduction projects ("Forest Waste").

II. Background

Sierra Northern is a subsidiary of Sierra Railroad, a privately-owned company that owns and operates short line railroads. Michael Hart, CEO of Sierra Railroad, has more than 25 years of experience forming and running environmentally friendly industrial companies. The U.S. Environmental Protection Agency named Mr. Hart an "Environmental Hero" for his work in biodiesel and the Obama White House named Mr. Hart a "Champion of Change" for his work in renewable energy. In the short line railroad industry, Sierra Northern has been a leader, implementing both criteria and GHG pollutant reducing technologies. Sierra Energy, which is also led by Mr. Hart, is a pioneer in developing and deploying waste-to-fuel technologies. Sierra Energy built and now operates a FastOx® gasifier unit that converts trash to diesel fuel or low carbon electricity at U.S. Army Garrison Fort Hunter Liggett, an Army training center east of Monterey, California.[2]

III. Sierra Northern and Sierra Railroad support the Proposed Repeal

Sierra Northern and Sierra Railroad support CARB's Proposed Repeal for multiple reasons. As stated in the Initial Statement of Reasons ("ISOR"), the Proposed Repeal provides more certainty to California locomotive operators. In addition, the Proposed Repeal avoids protracted and expensive litigation. Most importantly, the Proposed Repeal enables the more rapid implementation of voluntary and commercially viable strategies to achieve criteria and GHG pollutant reductions in the short line rail industry.

[2] See Peter Keating, "This Company Invented an Actual Magic Want to Turn Your Trash Into Clean Energy," May/June 2022 Issue of Inc. Magazine, at https://www.inc.com/magazine/202205/peter-keating/sierra-energy-gasification-mike-hart.html

The primary reason that the Proposed Repeal has the potential to catalyze more rapid reductions of criteria and GHG pollutant reductions is that it will expand funding opportunities to locomotive operators as is recognized in the ISOR:

> *The Proposed Repeal will also allow operators to be eligible for more funding programs for cleaner locomotives, because the operators would be achieving emission reductions extra to what is legally required of them. Some grant programs cannot fund projects that are done to comply with a regulation.*[3]

IV. Sierra Northern and Sierra Railroad have extensive short line rail experience and are Recognized Leaders in Upgrading Locomotives and Utilizing Low Carbon Fuels

As stated on the Sierra Railroad website,

> *Sierra Railroad is a pioneer in the energy, freight, and passenger rail industries. With Sierra Energy, Sierra Northern Railway, Mendocino's Skunk Train, Sacramento's River Fox Train, and Ventura's Sunburst Train, we embody the essential spirit of California, our home since the 1800s: bridging history with sustainability, connectivity, innovation, and growth while providing valuable services to California's businesses and helping craft memorable experiences for its residents and visitors alike.*[4]

Sierra Railroad's network of short line railroads delivers a multitude of industrial, commercial, passenger services to California's industries, businesses, citizens and visitors:

- Sierra Northern provides rail and intermodal freight transportation across Northern and Central California serving a wide variety of businesses and interchanging with BNSF and UP;
- Mendocino Railway owns the California Western Railway/Skunk Train that has been operating in the redwood forests of Mendocino County since 1885;
- Mendocino Railway also operates the Sacramento River Train/ River Fox Train located on the banks of the Sacramento River. Built in 1911 by the Northern Electric Company, the River Fox Train originally transported passengers throughout the Sacramento area; and,
- Sierra Northern and Mendocino Railway operate the Santa Paula Branch Line which was originally constructed in 1887 to haul citrus from fruit packing houses to communities along the Santa Clara River. Known as the Ventura Sunburst, the line provides freight and passenger operations.

To complement its extensive short line rail activities, Sierra Railroad's innovative energy start-up, Sierra Energy, is developing FastOx® gasification, a technology that turns trash into energy in the form of hydrogen without combustion or process emissions. From 2009 to 2013, Sierra Energy developed and validated the FastOx® technology at the Renewable Energy Testing Center located at McClellan Air Force Base in Sacramento. With the support of the U.S. Department of Defense and the CEC, Sierra Energy subsequently built its first demonstration facility pictured below in partnership with the U.S. Army at Fort Hunter Liggett near Monterey.[5]

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[3] California Air Resources Board, "Public Hearing to Consider the Proposed Repeal of the In-Use Locomotive Regulation; Staff Report: Initial Statement of Reasons (April 29, 2025), available at https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2025/locorepeal/isorlocorepealada.pdf, at p. 4.

[4] Sierra Railroad Company Website, at https://www.sierrarailroad.com/.

[5] Sierra Energy Website, "FastOx® Background & Milestones," at https://sierraenergy.com/fastox-background-milestones/.

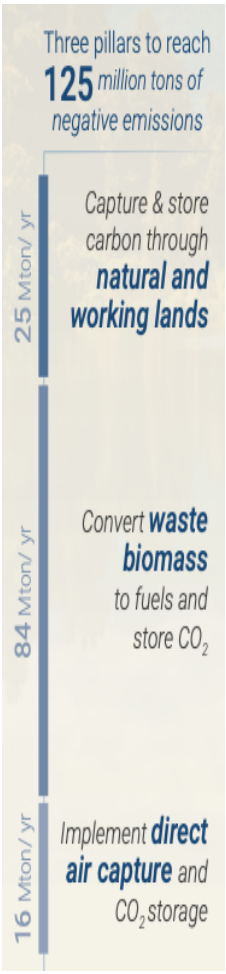
While the FastOx system can produce hydrogen from a wide range of waste streams, Sierra Energy has identified Forest Waste from wildfire risk reduction treatments as the most abundant and optimal feedstock to run Sierra Railroad's future fleets of hydrogen locomotives.

V. Sierra Energy's identification of waste woody biomass as the optimal California feedstock is fully supported by the Getting to Neutral Report[6]

Sierra Energy's identification of waste woody biomass as the optimal California feedstock is fully supported by the analysis completed at Lawrence Livermore National Laboratory (LLNL) for the groundbreaking study, "Getting to Neutral: Options for Negative Carbon Emissions in California." In the study, LLNL scientists identified a suite of technologies that will enable California to achieve carbon neutrality by 2045. As stated by LLNL: "The goal of the initiative is to identify solutions to enable global-scale CO_2 removal from the atmosphere and hit global temperature targets." The LLNL scientists utilized this methodology:

> *We analyzed how California can use resources and technology to achieve our goal of 125 million tons of negative emissions per year. We define negative emissions as CO_2 that is physically removed from the atmosphere, such as through biomass growth or direct air capture. It does not include reductions in current or projected emissions. We drew from existing literature, standard tools, and our own expertise to assess the feasibility and cost of more than 50 negative emissions pathways. We selected the lowest cost and most productive pathways to create a negative emissions strategy that has three pillars (Figure ES-2):*
>
> 1. *Capture and store as much carbon as possible through better management of natural and working lands*
> 2. *Convert waste biomass to fuels and store the CO_2*
> 3. *Remove CO2 directly from the air using purpose-built machines and store the CO_2*

As reflected by the chart at sidebar, the LLNL scientists determined that the second pillar- converting waste biomass to fuels and storing the CO_2- was the central pillar of the strategy. Fuels from waste biomass would deliver over two-thirds of the GHG reductions of all three pillars with the primary portion being forest biomass, a resource that California possesses in dangerous overabundance as will be further discussed in this Comment.



[6] Sarah E. Baker, Joshuah K. Stolaroff, George Peridas, Simon H. Pang, Hannah M. Goldstein, Felicia R. Lucci, Wenqin Li, Eric W. Slessarev, Jennifer Pett-Ridge, Frederick J. Ryerson, Jeff L. Wagoner, Whitney Kirkendall, Roger D. Aines, Daniel L. Sanchez, Bodie Cabiyo, Joffre Baker, Sean McCoy, Sam Uden, Ron Runnebaum, Jennifer Wilcox, Peter C. Psarras, Hélène Pilorgé, Noah McQueen, Daniel Maynard, Colin McCormick, Getting to Neutral: Options for Negative Carbon Emissions in California, January, 2020, Lawrence Livermore National Laboratory, LLNL-TR-796100 , at https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf , (hereafter Getting to Neutral Report) at p. 2-3. See also Lawrence Livermore National Laboratory, "New Lab report outlines ways California could reach goal of becoming carbon neutral by 2045, at https://www.llnl.gov/article/46046/new-lab-report-outlines-ways-california-could-reach-goal-becoming-carbon-neutral-2045

Regarding the scale of waste biomass in the State, the Getting to Neutral Report stated,

Convert Waste Biomass to Fuels and Store CO_2
Waste biomass is widely available across California, with about 56 million bone dry tons per year available from trash, agricultural waste, sewage and manure, logging, and fire prevention activities (…). Today, this biomass returns its carbon to the atmosphere when it decays or burns in prescribed fires or wildfires, or is used to produce energy at a power plant that vents its carbon emissions. (…)

Converting this biomass (primarily forest biomass) into fuels with simultaneous capture of the process CO_2 emissions holds the greatest potential for negative emissions in the State. A broad array of processing options is available, and includes (…) conversion of woody biomass to liquid fuels and biochar through pyrolysis; and conversion of woody biomass gaseous fuels through gasification."(…)[7]

VI. The Following State-level Initiatives Will Unlock Grant Funding and Accelerate the Voluntary Transition of California Short Lines to Zero Emission Locomotives

Sierra Northern and Sierra Railroad respectfully recommend that CARB undertake the following regulatory initiatives and analyses in close coordination with the Governor's Office and other state agencies to accelerate the transition of California short line switching locomotives to hydrogen fuel.

a) Adopt a firm policy of technology neutrality for zero emission locomotives that places hydrogen-fueled and battery-powered locomotives on a level playing field.
b) Undertake a review of the Carl Moyer Program (CMP) Guidelines specific to short line locomotives and infrastructure to identify and expand CMP eligibility for zero emission locomotives. The review should include industry workshops and industry working groups to inform appropriate revisions. The review and revisions are necessary because the 2024 CMP Guidelines which are attached as **Exhibit B** provide guidance grounded upon the In-Use Locomotive Regulation that CARB has proposed to repeal in this proceeding.[8] Assuming that the In-Use Locomotive Regulation is repealed, the revised CMP guidance should delete all references to the regulation and should provide extensive detail regarding the eligibility of zero emission locomotives, hydrogen production technologies, and hydrogen storage and infrastructure to receive CMP funding.
c) CARB should work cooperatively with the CEC, the Public Utilities Commission (CPUC) and the Governor's Office of Business and Economic Development (GO-Biz) to undertake a review of all other potentially relevant California funding programs to explore opportunities to identify and to expand program eligibility for zero emission locomotives, hydrogen production technologies, storage and infrastructure.
d) For identified funding programs, the respective agency should issue guidance that details the eligibility of zero emission locomotives, hydrogen production technologies, storage and infrastructure to receive funding.

[7] Id. at p. 4-5.
[8] See generally CARB, "2024 California Moyer Program Guidelines," overview page at https://ww2.arb.ca.gov/guidelines-carl-moyer, "Chapter 6: Locomotives," available at https://ww2.arb.ca.gov/sites/default/files/2024-11/Chapter%206.pdf; see e.g., "Chapter 6: Locomotives, I. Guidance, A. Projects Eligible for Funding," which states, "Funding Opportunities may be limited due to CARB's In-Use Locomotive Regulation, (…)"

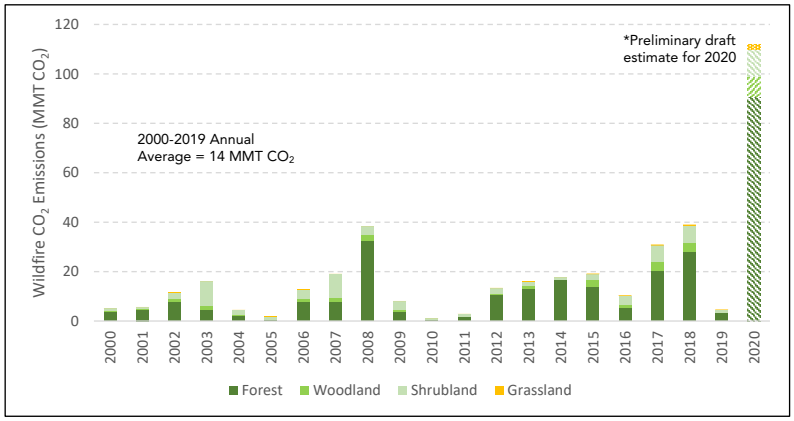
VII. The Escalating Rate of Wildfires is Drastically Increasing Criteria Pollutant and GHG Emissions and Causing Fatalities and Long-term Health Effects among California Citizens

Pursuant to Senate Bill 901, CARB in 2020 prepared a Draft Report entitled, "Greenhouse Gas Emissions of Contemporary Wildfire and Forest Management Activities." (the "Wildfire GHG Report")[9] The Wildfire GHG Report contained the following estimates regarding the annual wildfire GHG emissions for the years 2000-2019 and a preliminary draft estimate for 2020.[10]

Wildfire Emissions

Wildfire activity varies as landscapes cycle through periods of vegetation fuel abundance and scarcity in response to climate, management, and ignitions. Using a vegetation combustion model and geospatial fire perimeters, annual wildfire GHG emissions in California were calculated for the years 2000–2019 (Figure E-1)

Figure E-1. Annual wildfire CO_2 emissions (million metric tons, MMT) by general vegetation category.



**Preliminary draft estimate of 2020 wildfire emissions will be updated and revised when CAL FIRE's final fire perimeters become available in mid-2021.*

CARB annually produces the AB 32 GHG Inventory which estimates anthropogenic emissions within California and for imported electricity.[11] The AB 32 GHG Inventory is one tool to track progress of California's climate programs toward achieving statewide GHG targets. When juxtaposed with CARB's estimate of 2020 wildfire emissions, the AB 32 GHG Inventory dramatically illustrates the scale of California's wildfire problem in GHG terms. From a sectoral perspective, California's estimated 2020 GHG emissions from wildfires exceeded GHG emissions from the industrial and electrical power sectors.

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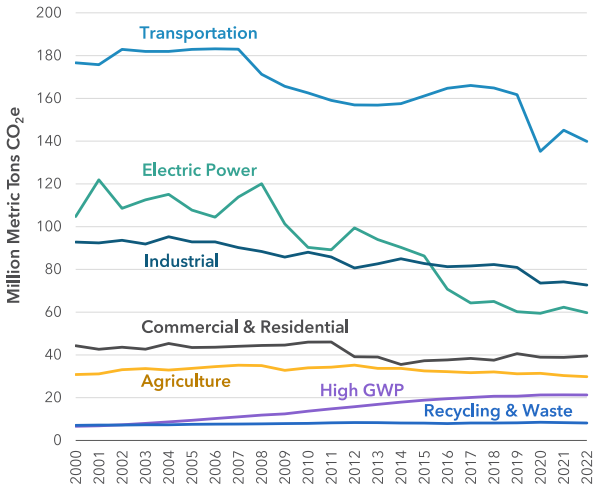
[9] CARB, "California Wildfire Emissions Estimates, December 31, 2020: Draft Report Available: Greenhouse Gas Emissions of Contemporary Wildfire and Forest Management Activities," explanatory page at https://ww2.arb.ca.gov/wildfire-emissions.

[10] CARB, "California Wildfire Emissions Estimates, December 31, 2020: Draft Report Available: Greenhouse Gas Emissions of Contemporary Wildfire and Forest Management Activities," draft Wildfire GHG Report at https://ww3.arb.ca.gov/cc/inventory/pubs/ca_ghg_wildfire_forestmanagement.pdf.

[11] CARB, "California Greenhouse Gas Emissions from 2000 to 2022: Trends of Emissions and other Indicators," (Date of Release: September 20, 2024), available at https://ww2.arb.ca.gov/sites/default/files/2024-09/nc-2000_2022_ghg_inventory_trends.pdf.

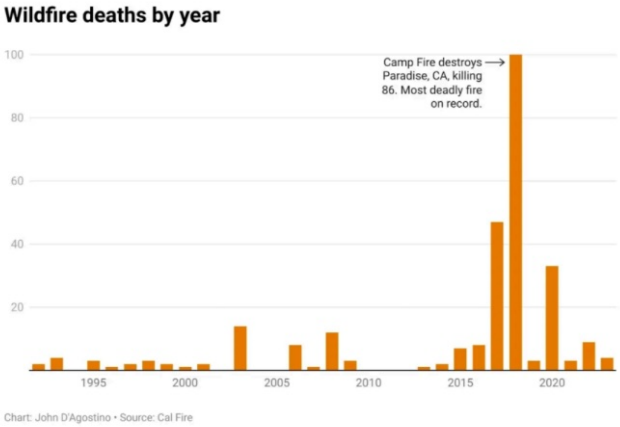
Figure 4. Trends in California GHG Emissions.



2020 WILDFIRE EMISSIONS

Figure 4 shows changes in emissions by Scoping Plan sector between 2000 and 2022.

The devastating direct impacts of wildfires on California citizens are increasingly severe as revealed by the escalating rate of wildfire fatalities in the State. The following chart illustrates CalFire data regarding wildfire deaths by year including residents and fire fighters.[12]



The long-term health impacts to California citizens have been found to be even more severe according to research conducted by the University of California at Los Angeles' Fielding School of Public Health and the Luskin Center for Innovation. Their study published in in Science Advances was based on mortality attributable to $PM_{2.5}$ emissions from California wildfires from 2008 to 2018. The study found that the inhalation of fine particulate matter during that 11-year period led to 52,500 to 55,700 deaths with an associated economic impact of $432 billion to $456 billion in California.[13]

[12] Cart, Julie, CALMATTERS, "California infernos in January? Here's why wildfire season keeps getting longer and more devastating," (January 16, 2025) at https://calmatters.org/explainers/california-wildfire-season-worsening-explained/.

[13] UCLA Newsroom, "The death toll from wildfire smoke," (June 7, 2024), at https://newsroom.ucla.edu/releases/the-death-toll-from-wildfire-smoke, summarizing the findings of Rachel Connolly *et al.*, Mortality attributable to $PM_{2.5}$ from wildland fires in California from 2008 to 2018. *Sci. Adv.***10**, eadl1252(2024). DOI:10.1126/sciadv.adl1252, available at https://www.science.org/doi/10.1126/sciadv.adl1252 - core-collateral-metrics.

VIII. **Sierra Northern and Sierra Railroad Urge CARB, CalFire, GoBiz and other California Agencies to Leverage the Power of the Low Carbon Fuel Standard to Create Demand for Forest Waste and Reduce Wildfire Risk**

Designed and administered by CARB, California's Low Carbon Fuel Standard ("LCFS") has proven to be one of California's most effective and powerful GHG reducing programs. Over the past fourteen years, the generation of LCFS credits (and the corresponding decrease of carbon intensity per energy unit of fuel) has ramped up from approximately 2 million metric tons ("MMT") in 2013 to over 30 MMT in 2024. The LCFS credit market has yielded between 3 to 5 billion dollars in annual value in recent years.[14] Perhaps the most dramatic real-world impact of the LCFS market has been to transform California's diesel market to a market dominated by low carbon renewable diesel and biodiesel, with high carbon petroleum diesel now holding a minority market position. As stated by California Air Resources Board Executive Officer, Dr. Steven Cliff: "As technological advances put a zero-emissions future within reach, the use of cleaner fuels offers an essential tool to reduce pollution now. A 50% reduction in diesel means cleaner air, healthier communities and a commitment to reaching carbon neutrality in California by 2045."[15]

CARB possesses the opportunity and capability to utilize the LCFS program as a demand-creating tool for low carbon fuels produced using California Forest Waste that is sourced from wildfire risk reduction projects. Forest waste can be utilized as a feedstock to generate electricity to run electric vehicles, to produce hydrogen to run locomotives, and to produce liquid fuels for cars and trucks. However, to harness the power of the LCFS, CARB must dedicate significant resources to develop a carbon intensity ("CI") score for California Forest Waste. This work should be done in close cooperation with the most qualified state agency in the prevention and control of wildfires, CalFire. To be effective, the California Forest Waste CI must be developed from a macroscopic rather than microscopic perspective. The resulting defined feedstock category of California Forest Waste should be practicable to implement at massive scale. As an example of an approach that would not create demand for woody biomass sourced from wildfire risk reduction treatments, CARB should not establish multiple CI scores for California Forest Waste that vary according to forest type, tree density, altitude, moisture content or other variables.

Instead, CARB's and CalFire's joint CI analysis of California Forest Waste should be grounded upon the existing record of massive and recurring GHG emissions from recent California wildfires. The objective of the joint analysis should be a scientifically defensible determination regarding this question: ***To what extent will California's contemporary wildfire GHG emissions will be reduced by prescribed wildfire risk reduction treatments per ton of woody biomass removed?*** Once this question is answered, CARB will be in a position to establish a California Forest Biomass CI score that can be integrated into all future LCFS pathway for fuels produced using this feedstock.

Given that CARB estimated that over 100 MMT of GHG emissions were released in the 2020 wildfires which were caused or exacerbated by unhealthy and untreated forests, there is tremendous potential to avoid future wildfire GHG emissions through Forest Waste removal. Once this is recognized within the LCFS program, a virtuous cycle will be established. A zero or subzero CI score for California Forest Waste used as a feedstock will create value for California Forest Waste used to produce hydrogen, electricity or liquid fuels used for transportation. This will create substantial value and demand for

[14] See LCFS Data Dashboard and underlying spreadsheet data for Figures 2, 3, 4, available at https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard.

[15] CARB, "For first time, 50% of California diesel fuel is replaced by clean fuels," at https://ww2.arb.ca.gov/news/first-time-50-california-diesel-fuel-replaced-clean-fuels.

California Forest Waste. Creating substantial value for Forest Waste will dramatically lessen the costs of wildfire risk reduction by off-setting biomass removal and transportation costs and will dramatically increase the feasibility of meeting California's massive wildfire risk treatment goals. Ultimately, the establishment of a zero or sub-zero CI score will serve to reduce California's wildfire GHG emissions and reduce direct fatalities and long-term health impacts to California citizens from wildfires.

Further support and more detailed analysis in support of these recommendations is contained in **Exhibit C**, "Turning Wildfire Tinder Into Low Carbon Fuels, A White Paper for Policy Makers."

IX. Pending Federal Regulatory Action May Create Additional Market Demand for Woody Biomass Sourced from Wildfire Risk Reduction Treatments which would Amplify the Benefits of a LCFS CI Score for California Forest Waste

The federal Renewable Fuel Standard ("RFS") has been an impediment to the production of low carbon transportation fuels from woody biomass because RFS credits ("RINs") generally cannot be generated from fuel produced from woody biomass feedstock sourced from national forest lands. However, the U.S. Environmental Protection Agency ("EPA") on June 13, 2025, announced proposed RFS standards for 2026 and 2027 (the "RFS Set 2 Proposal") and requested comments regarding how the RFS woody biomass regulations could be revised to better address wildfire risk reduction and best maximize the eligibility of woody biomass residues.

Within the "Summary of the Key Provisions of This Action," EPA stated:

> (…) *Our request for comment includes, but is not limited to:*
> (…)
> *Program enhancements to increase the use of qualifying woody-biomass to produce renewable transportation fuel. We specifically request comment on the extent to which the renewable biomass definition in 40 CFR 80.2 aligns with current wildfire risk potential and corresponds to wildfire ignition behavior science and how to best maximize the eligibility of woody biomass residues generated at sawmills and other forest products manufacturing businesses that have not been adulterated by chemicals or other non-wood contaminants.*
> (…)[16]

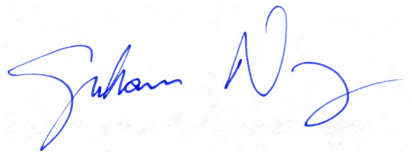
The RFS Set 2 Proposal establishes the possibility that EPA will expand the eligibility of woody biomass that can be used to produce credit-generating transportation fuels within the federal RFS program. We encourage CARB to consider engaging with EPA to provide input on the development of the appropriate definition of qualifying woody biomass in the RFS. From a fuel producer standpoint, the higher the level of alignment between the LCFS and RFS regarding feedstock eligibility issues, the greater the potential to utilize California Forest Waste as a feedstock and to create demand for woody biomass removed during wildfire risk reduction projects.

[16] U.S. Environmental Protection Agency, "Renewable Fuel Standard (RFS) Program: Standards for 2026 and 2027, Partial Waiver of 2025 Cellulosic Biofuel Volume Requirement, and Other Changes," Rule Summary Page at https://www.epa.gov/renewable-fuel-standard-program/proposed-renewable-fuel-standards-2026-and-2027#additional-resources, Proposed Rule at https://www.epa.gov/system/files/documents/2025-06/11947-01-oar-rfs-set2-nprm-20250613.pdf, (unofficial version, official version not yet released but will be printed in the Federal Register), excerpt from p. 9, 17 of unofficial version.

X. Conclusion

We appreciate the opportunity to submit these comments and remain available for additional engagement regarding the issues raised in this Comment and the opportunities that exist to enhance the benefits and to reduce the costs of transitioning California's short line fleet.

Sincerely,



Graham Noyes

Cc: Michael Hart, President and CEO, Sierra Railroad
Kennan H. Beard III, CEO, Sierra Northern Railway

EXHIBIT A

H_2 locomotive operational testing now underway

UC RIVERSIDE
BALLARD
valley vision
GTI ENERGY
Railpower Tech
FRONTIER energy
VELOCITY STRATEGIES

STATE OF CALIFORNIA
ENERGY COMMISSION

SACRAMENTO METROPOLITAN
AIR QUALITY
MANAGEMENT DISTRICT

CalSTA
CALIFORNIA
STATE TRANSPORTATION
AGENCY

Railpower, Inc

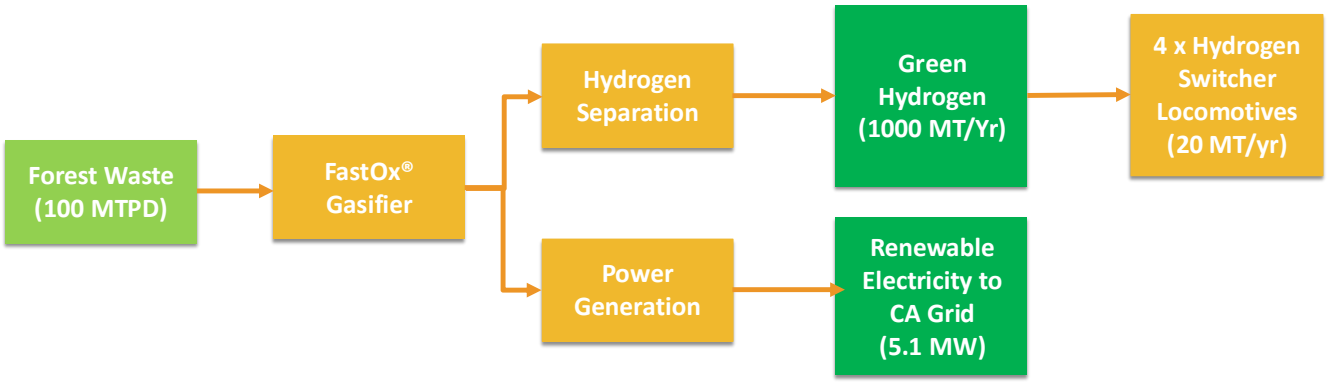
A Legacy of Innovation, The Future of Zero-Emission Switcher Technology

Railpower has long been a recognized name in the rail industry, with a legacy rooted in pioneering hybrid and low-emission locomotive technology. Founded in 2001, Railpower introduced groundbreaking locomotive designs that combined battery power with a compact diesel engine to improve fuel efficiency and reduce emissions. The company's innovative platforms including the GG20B, RP20BD, and other low-emission models were deployed across North America, helping railroads meet increasingly stringent environmental regulations.

In 2025, Railpower, Inc. launching a bold new chapter for the brand. This has positioned the company as the industry's leading developer of zero-emission hydrogen locomotives and next-generation rail technology.

TRANSFORMING CALIFORNIA'S SHORT LINE RAIL INDUSTRY

SIERRA ENERGY



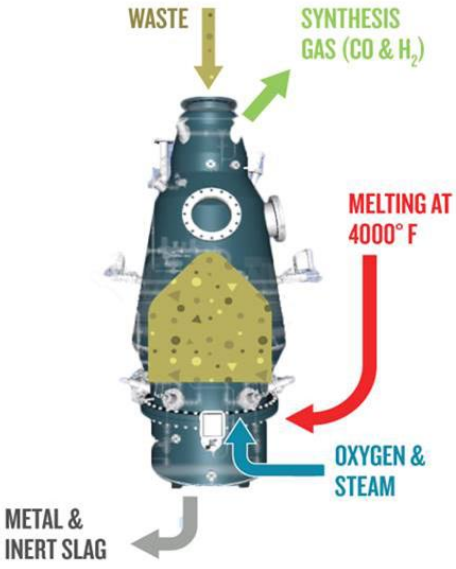
- Sierra Railroad could develop 5 projects in Mendocino, Stanislaus, Tuolumne, Ventura and Yolo counties
- Other rail companies could also develop projects

Fort Hunter Liggett (FHL) Pilot Facility

- Phases 1, 2 and 3 of the testing at FHL, prove how essential scaled-down commercial pilot facilities like these are to technology development and licensing companies

U. S. Army Garrison Fort Hunter Liggett (FHL)
Monterey County, California

The FastOx® Technology



Robust, Fixed-Bed Gasifier

- Few moving parts
- Low maintenance

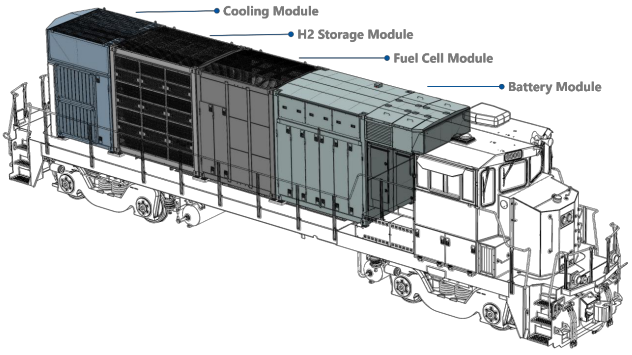
Oxygen-Blown Slagging Gasification

- High-quality syngas
- **Non-leaching vitrified stone – no hazardous waste**
- No dilutive nitrogen

Proprietary Tar Control Technology

- Converts disruptive tars
- Higher syngas yield
- Simplified gas cleaning

Visionary Breakthroughs
Building a Clean Energy Future for Rail



An Industry Leader

Railpower is poised to become the primary platform for commercializing hydrogen fuel cell locomotives, with a focus on serving the short-line and switching sectors.

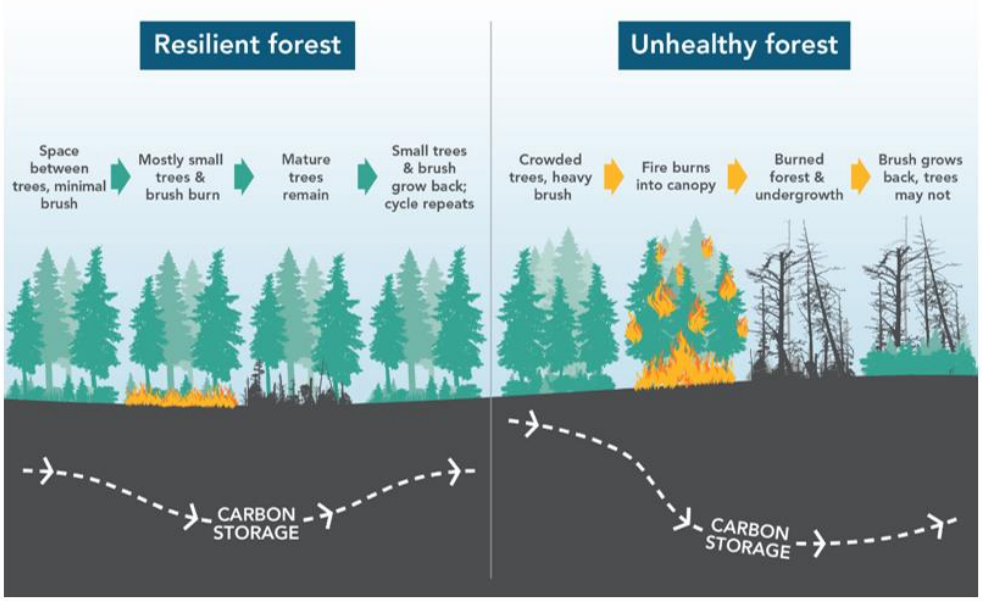
Railpower will build on Sierra Northern Railway's success in developing and deploying SERA 193, the world's first four-axle hydrogen powered switcher locomotive, funded in part by the California Energy Commission (CEC). Entering full operational testing in 2025, SERA 193 represents a breakthrough in zero emission clean rail technology.

With significant backing from the California State Transportation Agency (CalSTA), Railpower and Sierra Northern Railway will build three second-generation four-axle zero emission hydrogen fuel switcher locomotives, further refining the technology and expanding its commercial viability.

Once these four zero-emission locomotives are successfully integrated into service, **Railpower will begin offering commercial hydrogen switching locomotives to the broader rail industry, leveraging its proven platforms and leadership in clean rail innovation.**

Forest Waste will be used in the Rail Emissions Reduction Project

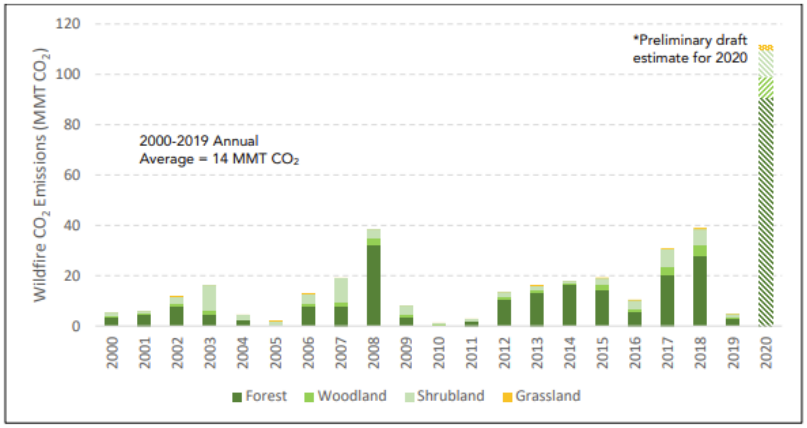
SIERRA ENERGY



From CARB FAQ – Wildfire Emissions

Forest Waste will be used in the Rail Emissions Reduction Project

Figure E-1. Annual wildfire CO_2 emissions (million metric tons, MMT) by general vegetation category.



**Preliminary draft estimate of 2020 wildfire emissions will be updated and revised when CAL FIRE's final fire perimeters become available in mid-2021.*

From CARB's Wildfire Emissions Estimates

THANK YOU FOR THE OPPORTUNITY

EXHIBIT B

CHAPTER 6: LOCOMOTIVES

Table of Contents

I. Guidance

This chapter describes the minimum criteria and requirements for Carl Moyer Memorial Air Quality Standards Attainment Program (Moyer Program) locomotive projects. Air quality management districts or air pollution control districts (air districts) may set more stringent requirements based upon local priorities.

Please note that to fund projects in this category, Chapters 2 and 3 include general provisions and administrative requirements. Appendices A-E provide additional supporting information.

A. Projects Eligible for Funding

The Moyer Program provides incentives to upgrade old, high-polluting locomotives to Tier 4 or cleaner units. Railcar movers which have tires or mounted tracks, that replace switcher locomotives are considered locomotives for the purposes of the Moyer Program. Funding opportunities may be limited due to CARB's In-Use Locomotive Regulation, and the South Coast and Statewide Memoranda of Understanding (MOU) with Class 1 railroads (See Table 6-1).

Table 6-1
Summary of Locomotive Regulations and MOUs

Railroad Class	Subject to CARB Regulation or MOU
Class 1 Freight Railroads (Burlington Northern Santa Fe Railroad and Union Pacific Railroad)	CARB's In-Use Locomotive Regulation[1] and 1998 South Coast MOU[2]
Class 2 and 3 Freight Railroads and Passenger Railroads	CARB's In-Use Locomotive Regulation[1]

[1] Projects must be surplus, and applicants must be in compliance with the requirements of the regulation to be eligible for Moyer funding. See Locomotive Fact Sheets:
[2] The South Coast MOU limits funding eligibility for Class 1 freight railroad replacement or engine repower projects in the South Coast. See Rail Emission Reduction Agreements.

1. Project Types

Locomotive projects eligible for Moyer Program funding include:

(A) Locomotive Replacement: An older locomotive that includes an engine(s) with remaining useful life is replaced with a Tier 4 or cleaner locomotive.

(B) Locomotive Engine Repower: A Tier 4 or cleaner engine is installed in place of a higher-polluting engine in an existing locomotive.

(C) Locomotive Conversion: An older locomotive with a combustion engine is converted to a zero-emission locomotive.

(D) Locomotive Retrofit: A Tier 4 or cleaner emission control system is added to an in-use engine.

(E) Infrastructure Projects: See Chapter 10 for details regarding applicant eligibility and project types for infrastructure to support zero-emission locomotives.

Two-for-One Calculations – Projects in which two or multiple locomotives of similar design and function are replaced with one or multiple locomotives are eligible for funding. The project is eligible for a grant based on the combined usage and emission reductions achieved from the baseline and reduced locomotives respectively.

Leasing is allowed for zero-emission locomotives replacement projects only. The lease term must be equal to the project life and be between three to seven years. The contract must specify the responsible party in case Moyer Program requirements are not met anytime throughout the contract term. The lessor and lessee must both sign and agree to the contract terms. All lease projects must destroy the baseline locomotive.

2. Maximum Eligible Funding Amounts

Table 6-2 summarizes the maximum eligible funding for each project type. All projects are also subject to the cost-effectiveness threshold defined in Appendix C.

Table 6-2
Maximum Grant Amount for Moyer Program Locomotive Projects

Railroad Class/Type	All Project Types
Class 1/Class 2 Line Haul	80%
Class 3, Switcher, and Passenger	85%

B. Emission Standards

The U.S. EPA has adopted regulations for exhaust emission standards for new and remanufactured locomotives. For reference, Tables 6-3 and 6-4 below summarize the hydrocarbon (HC), oxides of nitrogen (NOx) and particulate matter (PM) standards in grams per brake horsepower-hour (g/bhp-hr) for the 1998 Federal Standards and the 2008 Federal Standards.

Table 6-3
U.S. EPA Locomotive Emission Standards (g/bhp-hr) Based on 1998 Federal Standards[1]

Tier and Engine Model Year	Type	NOx	HC	PM10
Uncontrolled Pre-1973	Line-haul and Passenger	13.5	1.00	0.60
	Switcher	17.4	2.10	0.72
Tier 0 1973 – 2001	Line-haul and Passenger	9.5	1.00	0.60
	Switcher	14.0	2.10	0.72
Tier 1 2002-2004	Line-haul and Passenger	7.4	0.55	0.45
	Switcher	11.0	1.20	0.54
Tier 2 2005 – 2011	Line-haul and Passenger	5.5	0.30	0.20
	Switcher	8.1	0.60	0.24

[1] PART 1033—CONTROL OF EMISSIONS FROM LOCOMOTIVES

Table 6-4
U.S. EPA Locomotive Emission Standards (g/bhp-hr) Based on 2008 Federal Standards[1]

Tier and Engine Model Year	Type	NOx	HC	PM10
Tier 0+ 1973-2001	Line-haul and Passenger	7.4	0.55	0.22
	Switcher	11.8	2.10	0.26
Tier 1+ 2002-2004	Line-haul and Passenger	7.4	0.55	0.22
	Switcher	11.0	1.20	0.26
Tier 2+ 2005-2011	Line-haul and Passenger	5.5	0.30	0.10
	Switcher	8.1	0.60	0.13

Tier and Engine Model Year	Type	NOx	HC	PM10
Tier 3 2011-2014	Line-haul and Passenger	5.5	0.30	0.10
	Switcher	5.0	0.60	0.10
Tier 4 2015 or later	Line-haul and Passenger	1.3	0.14	0.03
	Switcher	1.3	0.14	0.03

[1] PART 1033–CONTROL OF EMISSIONS FROM LOCOMOTIVES

C. Project Criteria

The minimum qualifications for locomotives are listed below. All projects must also conform to the requirements in Chapter 2: General Criteria, and in Chapter 3: Program Administration. Participating air districts retain the authority to impose additional requirements to address local concerns. Note that railroad classes are defined in Appendix B.

1. General Locomotive Project Criteria

(A) Baseline emission factors must reflect the tier level required by federal locomotive remanufacturer standards (i.e., the baseline emission factors are the required remanufacture standards, which may not be the certification standard of the baseline locomotive).

(B) Class 1 freight locomotives subject to the South Coast Memorandum of Understanding (MOU) are only eligible for Moyer Program funding on a case-by-case basis. These locomotive projects must be excluded from the fleet average emission rate calculations which demonstrate compliance with the MOU provisions. The baseline emission rates used to determine emission reductions and cost-effectiveness for these locomotive projects reflect the U.S. EPA Locomotive Tier 2 emission rates for line-haul and switch locomotives.

(C) Air districts must verify applicants are in compliance with all requirements of CARB's In-Use Locomotive Regulation and emission reductions are early or extra to the Regulation's requirements. CARB must verify projects utilizing alternative options or extensions under the regulation. These projects may need to be handled on a case-by-case basis.

(D) Military and industrial railroads are considered Class 3 railroads for the purposes of the Moyer Program.

(E) Locomotive project activity must be based upon fuel consumption. If fuel consumption is not available, megawatt hours from the electronically logged data may be used.

(F) Moyer Program funds cannot be used to pay for labor or parts used during routine maintenance.

(G) Air districts may enter into contract and work may begin on a locomotive project prior to U.S. EPA certification, CARB verification, or CARB equipment approval. In this instance, the air district contract with the grantee must specify that any work performed is done at the grantee's own risk. Air districts cannot make payment until certification, verification, or approval been received.

(H) Participant must have owned the baseline locomotive for at least one year prior to application submittal, and the locomotive must be operational.

(I) For replacement, repower, and conversion projects the baseline locomotive engine or engines must be destroyed. At a minimum, the destruction of a locomotive engine must include a hole in the engine block, between the cylinders, with a diameter of at least eighteen inches at the narrowest point. The hole must be irregularly shaped (i.e., no symmetrical squares or circles) to render the engine permanently inoperable. Non-locomotive engines may follow off-road guidance, requiring a minimum hole diameter of three inches.

(J) All locomotive projects must have a minimum three-year warranty that covers both parts and labor.

2. Project Life

(A) The minimum project life for a locomotive project is one year.

(B) The maximum project life for a locomotive project is 15 years.

(C) Project lives may be limited due to CARB's In-use Locomotive Regulation.

(D) Project lives may include partial years, with a minimum duration of one month (e.g., project life could be one year and one month, totaling 13 months).

3. Locomotive Replacement

(A) Locomotives with an aggregate engine power rating greater than or equal to 1,006 horsepower (750 kW) must be certified by U.S. EPA or verified by CARB to achieve Tier 4 locomotive emission standards or cleaner.

(B) Locomotives with an aggregate engine power rating less than 1,006 horsepower are not required to be certified by U.S. EPA to locomotive standards but are required to be certified to U.S EPA off-road (nonroad) emission standards or verified by CARB to meet or exceed the Tier 4 locomotive standards.

(C) Zero-emission locomotives must have CARB verification or approval.

(D) If a railcar mover is replacing a switcher locomotive, the applicant must evaluate and verify the replacement railcar mover is able to perform the duties of the baseline switcher locomotive.

(E) The baseline locomotive engine(s) must be destroyed. The grantee may

choose to retain the baseline locomotive chassis or donate the chassis to a museum or similar exhibit. Since locomotive components have a long lifespan, CARB recognizes the benefits of reusing and/or recycling baseline locomotives. To prevent the baseline locomotive body from being fitted with a similar high-polluting engine, the grantee must sign an agreement with the air district which will ensure, with due diligence, that for the remaining life baseline locomotive, if brought back into service, will be repowered to a Tier 4 or cleaner locomotive emission standard.

4. Locomotive Engine Repower

Purchase and installation of an engine meeting Tier 4 locomotive emission standards or cleaner. The engine must be certified by U.S. EPA or verified by CARB to be eligible for Moyer Program funding.

5. Locomotive Retrofit

Purchase and installation of a retrofit device meeting Tier 4 locomotive emission standards or cleaner. The retrofit device must be certified by U.S. EPA or verified by CARB to be eligible for Moyer Program funding.

6. Locomotive Conversion

Purchase and installation of a zero-emission conversion kit. The conversion kit must be certified by U.S. EPA, verified by CARB, or approved by CARB to be eligible for Moyer Program funding.

II. Acronyms

Acronym	Definition
AB	Assembly Bill
CARB	California Air Resources Board
bhp-hr/gal	Brake horsepower-hour per gallon
bhp-hr/yr	Brake horsepower-hour per year
CARL	Clean Air Reporting Log
CCR	California Code of Regulations
CO	Carbon Monoxide
DOT	Department of Transportation
G	Gram
g/bhp-hr	Gram per brake horsepower-hour
GMERP	Goods Movement Emission Reduction Program
GPS	Geographic Positioning System
Hp	Horsepower
Hr	Hour
H&SC	Health and Safety Code

Acronym	Definition
kW	Kilowatt
NOx	Oxides of Nitrogen
PM	Particulate Matter
PM10	Particulate Matter less than 10 microns in diameter
ROG	Reactive Organic Gas
SIP	State Implementation Plan
U.S. EPA	United States Environmental Protection Agency
V	Volt
YR	Year

III. Definitions

Air District or District: An air pollution control district or an air quality management district.

Air Pollution Control Officer: The air pollution control officer, executive director, executive officer or designee as determined by each air district.

California's Goods Movement Trade Corridor: The entirety of the South Coast Air Basin, San Joaquin Valley Air Basin, Sacramento Federal Ozone Nonattainment Area, San Francisco Bay Area Air Basin, San Diego County Air District, Imperial County Air District, and Port Hueneme.

Certification: A finding by the California Air Resources Board (CARB) or the U.S. EPA that a mobile source or emissions control device has satisfied applicable criteria for specified air contaminants.

Class 1 Freight Railroad: As defined by the Surface Transportation Board. As of January 2017, Union Pacific Railroad (UP), Burlington Northern and Santa Fe Railroad (BNSF), and their subsidiaries are the only Class 1 freight railroads operating in California.

Class 2 Freight Railroad: As defined by the Surface Transportation Board. As of January 2017, Arizona and California Railroad, Central Oregon and Pacific Railroad are the only Class 2 freight railroads operating in California.

Class 3 Freight Railroad: As defined by the Surface Transportation Board. Short-line railroads and military and industrial railroads are generally considered Class 3 freight railroads for the purposes of eligibility.

Cost-Effectiveness: A measure of the dollars provided to a project for each ton of covered emission reduction (H&SC Section 44275(a)(4)).

Covered Emissions: Emissions of oxides of nitrogen, particular matter, and reactive organic gases from any covered source.

Emission Factor (EF): A category specific estimate of emissions per unit of activity. On-road emission factors are based on CARB mobile source emission inventory model values. Off-

road emission factors are based on values applied in CARB category specific inventory models.

Freight Locomotive: A locomotive that hauls freight as its primary function.

Grant Amount: Contracted amount of Moyer funds for a project, which may not exceed the maximum dollar amount or maximum percentage of eligible cost specified by source category and project type.

Head End Power Unit: Most passenger locomotives are equipped with head end power (HEP) or hotel power, an onboard generator typically about a 500 horsepower that provides power to the passenger cars of the train for such functions as heating, lighting and air conditioning.

Incremental Cost: The cost of the project less a baseline cost that would otherwise be incurred by the applicant in the normal course of business. Incremental costs may include added lease, energy, or fuel costs pursuant to Health and Safety Code Section 44283 as well as incremental capital costs.

Maximum Grant Amount: The maximum amount of money a grantee is eligible to receive for a cost-effective Moyer Program project. The maximum grant amount for a project is the lowest of the three following values: (a) the grant amount at the cost-effectiveness limit; (b) the maximum percentage of eligible cost; or (c) any maximum dollar amount specified in the relevant source category chapter.

Memorandum of Agreement (MOA) or Memorandum of Understanding (MOU): A document recording the basic terms of a proposed transaction or setting forth the principles and guidelines under which parties will work together.

Project Life: The period for which the Moyer Program funds surplus emission reductions for a given project.

Rail equipment: Non-locomotive equipment designed for use on tracks, such as on- rail vehicles, railcar movers, sweepers, and wheel cranes that have tires or mounted tracks. Equipment that replaces switcher locomotives are considered locomotives for the purposes of the Moyer Program.

Repower: A repower is the replacement of the existing engine with an electric motor or a newer emission-certified engine instead of rebuilding the existing engine to its original specifications.

Retrofit: Modifications to the engine and fuel system so that the retrofitted engine does not have the same emissions specifications as the original engine, or the process of installing a CARB-verified emissions control system on an existing engine.

Sweeper/Scrubber: A large spark-ignition engine-powered piece of industrial floor cleaning equipment designed to brush and vacuum up small debris and litter and then scrub and squeegee the floor.

Switch Locomotive: A locomotive powered by an engine or engines typically totaling less than 2,300 total horsepower, and used to separate and move railcars from track to track or

transfer cars to and from regional carriers. All Class 3 railroad locomotives – including all short-line and military and industrial locomotives – are considered switch locomotives for the purposes of the Moyer Program eligibility.

Tier 1, 2, and 3 Engines: Engines that are subject to California Code of Regulations, title 13, Section 2423(b)(1)(A) and/or Code of Federal Regulations, title 40, part 89.112(a). This also includes engines certified under the averaging, banking, and trading program with respect to the Tier 1, 2, and 3 Family Emission Limits (FEL) listed in California Code of Regulations, title 13, Section 2423(b)(2)(A) and/or Code of Federal Regulations, title 40, part 89.112(d).

Tier 4 Engine: Engines that are subject to interim or final after-treatment based Tier 4 emission standards in California Code of Regulations, title 13, Section 2423(b)(1)(B) and/or Code of Federal Regulations, title 40, part 1039.101. This also includes engines certified under the averaging, banking, and trading program with respect to the Tier 4 FEL listed in California Code of Regulations, title 13, Section 2423(b)(2)(B) and/or Code of Federal Regulations, title 40, part 1039.101. For locomotives, the term refers to the Tier 4 (2015 engine model year) emission standards in the Code of Federal Regulations, title 40, Part 1033.

Uncontrolled Large Spark-Ignition Engines: Means pre-2001 uncertified engines and 2001-2003 certified 'noncompliant' large spark-ignition engines.

Verification: A determination by CARB or the U.S. EPA that a diesel emission control strategy meets specified requirements, based on both data submitted and engineering judgement.

Violator: An individual, company, or entity responsible for a violation of an environmental law, regulation, or rule.

IV. References

California Air Resources Board (July 2, 1998) South Coast Locomotive Fleet Average Emissions Program: Memorandum of Mutual Understandings and Agreements.
https://ww2.arb.ca.gov/sites/default/files/2018-06/loco_flt.pdf

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https://www.arb.ca.gov/bonds/gmbond/docs/prop_1b_goods_movement_2015_program_guidelines_for_implementation.pdf

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https://www.gpo.gov/fdsys/pkg/FR-1998-04-16/pdf/98-7769.pdf

United States Environmental Protection Agency (March 2007) Regulatory Announcement:

EPA Proposal for More Stringent Emission Standards for Locomotives and Marine Compression-Ignition Engines; EPA420-F-07-015.
http://nepis.epa.gov/Exe/ZyPDF.cgi/P1000509.PDF?Dockey=P1000509.PDF

United States Environmental Protection Agency (June 20, 2008) Final Rule: Control of Emissions from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder.
https://www.gpo.gov/fdsys/pkg/FR-2008-06-30/pdf/R8-7999.pdf

A WHITE PAPER FOR POLICY MAKERS

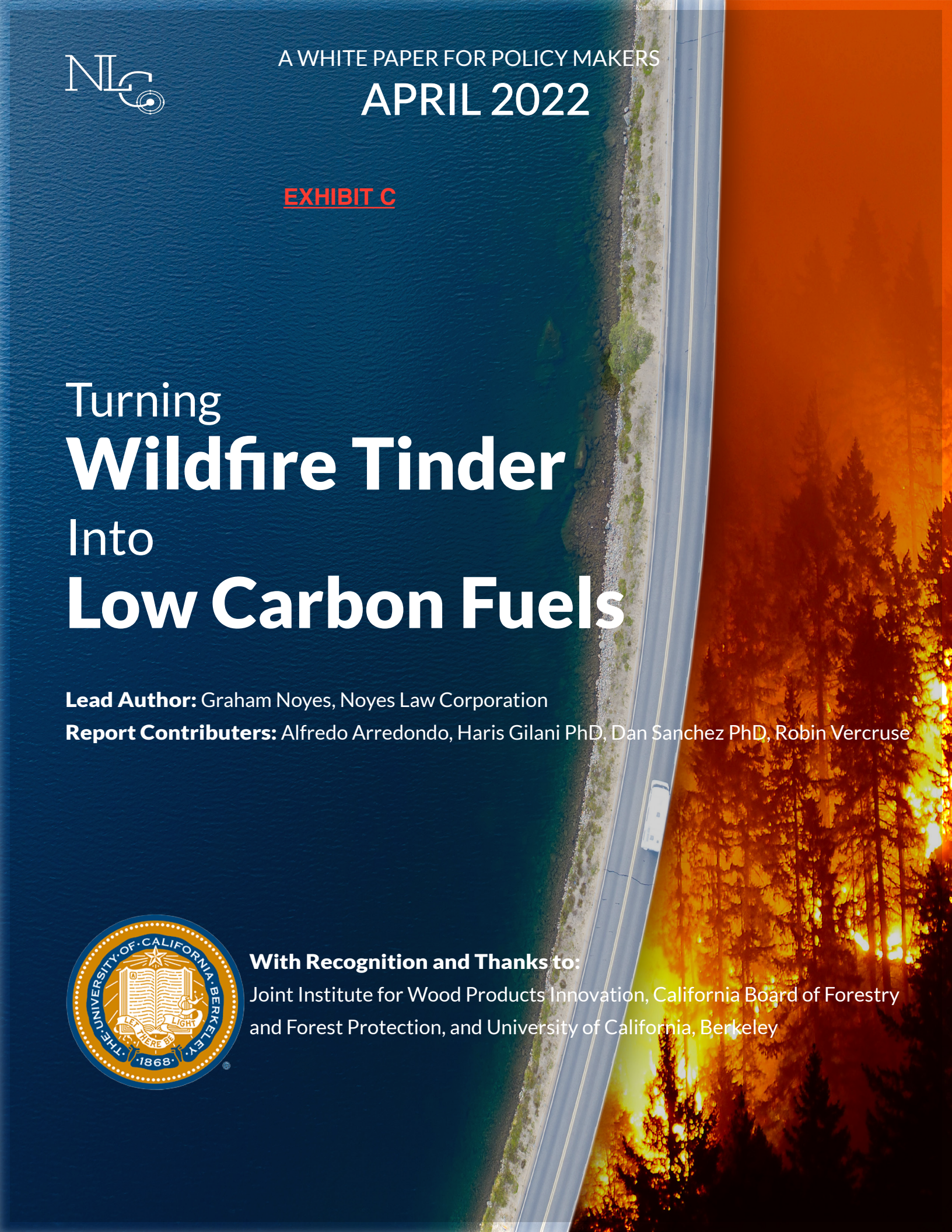
APRIL 2022

EXHIBIT C

Turning **Wildfire Tinder** Into **Low Carbon Fuels**

Lead Author: Graham Noyes, Noyes Law Corporation

Report Contributers: Alfredo Arredondo, Haris Gilani PhD, Dan Sanchez PhD, Robin Vercruse



With Recognition and Thanks to:

Joint Institute for Wood Products Innovation, California Board of Forestry and Forest Protection, and University of California, Berkeley

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OVERVIEW

This Woody Biomass Fuels Industry White Paper has been developed to assist California and federal policymakers chart an environmentally and economically sound course toward wildfire risk reduction and carbon neutrality. This proposed course of action maximizes the highest and best use of woody biomass generated by forest management activities: producing low-carbon transportation fuels using advanced processing technologies. The production of transportation fuels is the highest and best use of woody biomass because this feedstock is abundant and reliable, advanced technologies drastically reduce criteria pollutants and greenhouse gas (GHG) emissions relative to fossil fuel refining, and transportation is the hardest economic sector to decarbonize.

Based on the work of the Institute for Transportation Studies pursuant to AB 74, to achieve carbon neutrality by 2045, California must transition completely from fossil fuels to bio-based alternatives.[1]

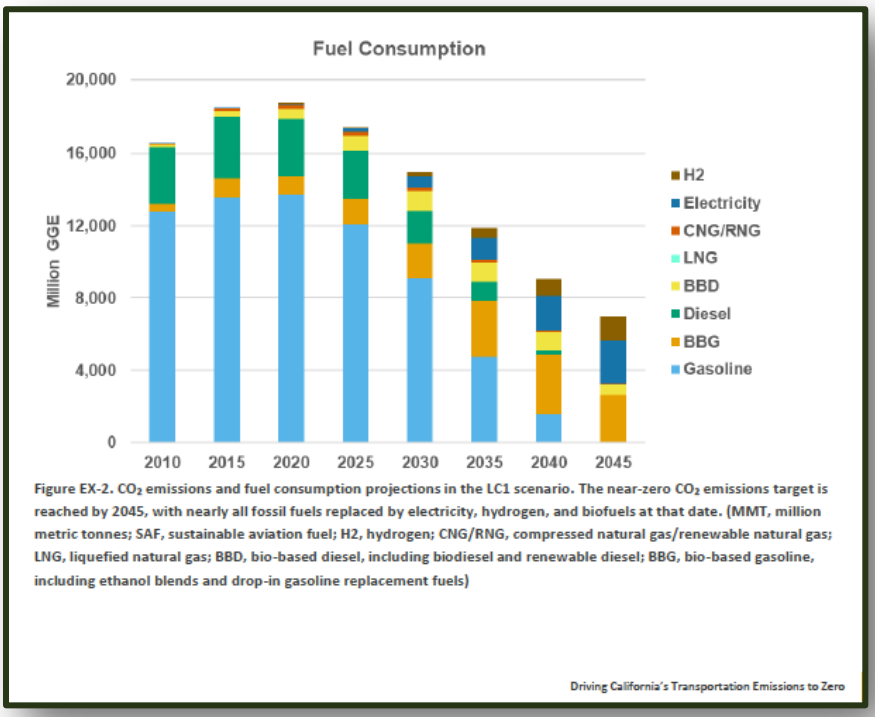


Figure EX-2. CO_2 emissions and fuel consumption projections in the LC1 scenario. The near-zero CO_2 emissions target is reached by 2045, with nearly all fossil fuels replaced by electricity, hydrogen, and biofuels at that date. (MMT, million metric tonnes; SAF, sustainable aviation fuel; H2, hydrogen; CNG/RNG, compressed natural gas/renewable natural gas; LNG, liquefied natural gas; BBD, bio-based diesel, including biodiesel and renewable diesel; BBG, bio-based gasoline, including ethanol blends and drop-in gasoline replacement fuels)

Producing low, very low, and zero-carbon fuels from woody biomass provides California with the opportunity to reap the jobs and economic benefits of fuel production that other states are currently enjoying. While California leads the nation in decarbonizing its transportation fuels, this has been achieved primarily through the importation of liquid fuels from other states and countries, with California currently importing over 90% of its low carbon liquid fuels.[2] In dramatic contrast to other feedstocks suitable for producing low carbon liquid

[1] Institute of Transportation Studies, "Driving California's Transportation Emissions to Zero," (April 2021), available at https://escholarship.org/uc/item/3np3p2t0)

[2] California Air Resources, Board, Low Carbon Fuel Standard (LCFS) Data Dashboard, Figure 10, at https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard

fuels, California currently possesses forest woody biomass in overabundance.

The scientific feasibility of deploying forest woody biomass in transportation has been validated by the second Carbon-Reduction Pillar of the Lawrence Livermore National Laboratory's Getting to Neutral Report:

> **Convert Waste Biomass to Fuels and Store CO_2**
>
> *"Waste biomass is widely available across California, with about 56 million bone dry tons per year available from trash, agricultural waste, sewage and manure, logging, and fire prevention activities (…). Today, this biomass returns its carbon to the atmosphere when it decays or burns in prescribed fires or wildfires, or is used to produce energy at a power plant that vents its carbon emissions. (…)*
>
> *Converting this biomass (primarily forest biomass) into fuels with simultaneous capture of the process CO_2 emissions holds the greatest potential for negative emissions in the State. A broad array of processing options is available, and includes (…) conversion of woody biomass to liquid fuels and biochar through pyrolysis; and conversion of woody biomass gaseous fuels through gasification."(…)*[3]

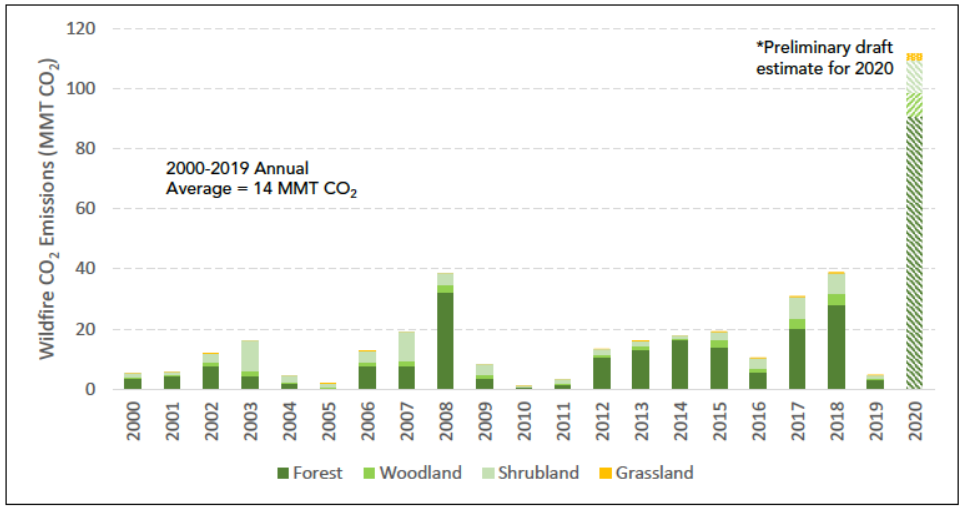
As a result of the changed conditions in the forests coupled with climate change, California's forests have changed from a carbon sink to a carbon source. Wildfires nationwide have drastically increased in intensity and frequency in recent years, creating not only increasing risk to life, health and property but also generating substantial GHG emissions to exacerbate the effects of climate change.[4] The national trend is particularly acute in California. However, due to its novelty and uncertainty, the new reality of wildfire GHG emissions from forests has not yet been integrated into California's climate policy.

---

[3] Sarah E. Baker, Joshuah K. Stolaroff, George Peridas, Simon H. Pang, Hannah M. Goldstein, Felicia R. Lucci, Wenqin Li, Eric W. Slessarev, Jennifer Pett-Ridge, Frederick J. Ryerson, Jeff L. Wagoner, Whitney Kirkendall, Roger D. Aines, Daniel L. Sanchez, Bodie Cabiyo, Joffre Baker, Sean McCoy, Sam Uden, Ron Runnebaum, Jennifer Wilcox, Peter C. Psarras, Hélène Pilorgé, Noah McQueen, Daniel Maynard, Colin McCormick, Getting to Neutral: Options for Negative Carbon Emissions in California, January, 2020, Lawrence Livermore National Laboratory, LLNL-TR-796100 , at https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf , (hereafter Getting to Neutral Report) at p. 4.

[4] California Air Resources Board https://ww3.arb.ca.gov/cc/inventory/pubs/ca_ghg_wildfire_forestmanagement.pdf and https://ww2.arb.ca.gov/wildfire-emissions

Figure E-1. Annual wildfire CO_2 emissions (million metric tons, MMT) by general vegetation category.



California's forests cover large areas of the State and are a mix of private, federal and state lands. As such, the solution to California's wildfire crisis requires an unprecedented level of coordination between state and federal policymakers, and also between agencies. This White Paper is intended to facilitate and support that coordination. The authors and industry participants are fully available for additional engagement.

The White Paper's recommendations were developed based on the input of eight companies developing real-world commercial facilities that convert woody biomass to hydrogen, renewable natural gas, and drop-in liquid replacement fuels for petroleum-based gasoline, diesel and jet fuel. The policy recommendations of this report have been derived in part from and informed by the California Joint Institute for Wood Products Innovation's 50-member working group on "Advancing collaborative action on forest biofuels" to promote policy and market development for forest biofuels. **("Forest Biofuels Report").** [5]

The White Paper is organized as follows:

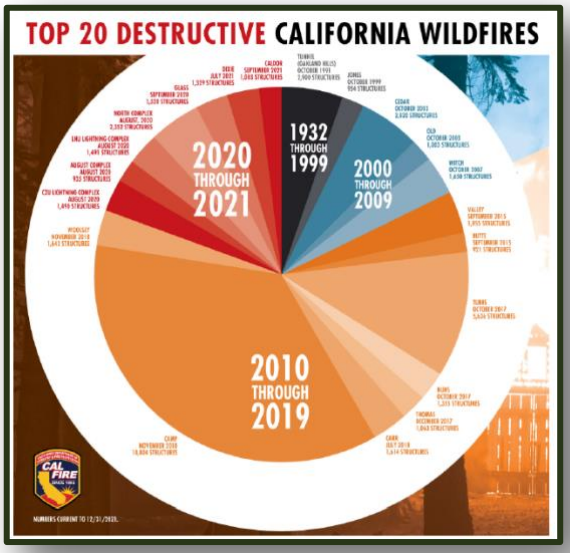
- Overview
- Challenges
- Summary of Recommendations
- Detailed Policy Recommendations
- Forecasted Market Growth with Policy Support
- Summary for Policymakers from the Joint Institute for Wood Products Innovation Report
- Company Profiles of the Nine Consortium Companies with Facility and Process Details

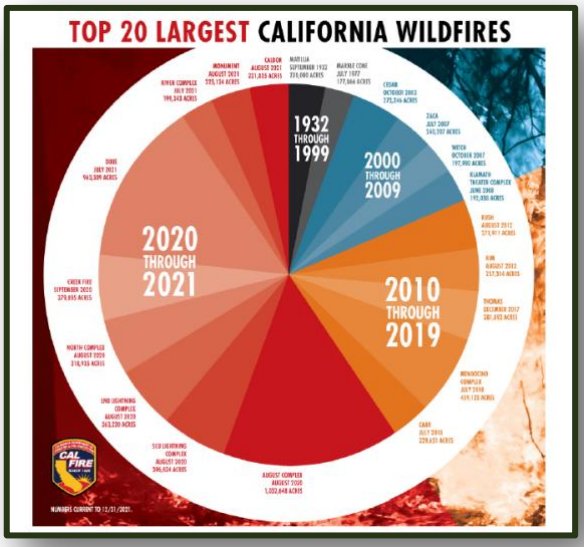
[5] Joint Institute for Woody Products Innovation, California Board of Forestry and Fire Protection, posted in 2022 Reports, website at https://bof.fire.ca.gov/board-committees/joint-institute-for-wood-products-innovation/ , report at https://bof.fire.ca.gov/media/mn5gzmxv/joint-institute-forest-biofuels_final_2022_ada.pdf

CHALLENGES

Challenge #1—California's Wildfire Crisis is Immediate and Massive

In May of 2018, Governor Jerry Brown issued an Executive Order stating, in part, "recent wildfires have been the largest, deadliest, most destructive and costliest in history," and establishing the Joint Institute for Wood Products Innovation to "accelerate research, development and adoption of advanced forest management and wood products manufacturing."[6] The risks that Governor Brown identified in 2018 have only worsened in subsequent years.[7] It is only due to the exhaustive, brave and capable work of CalFire, the US Forest Service, and the Brown and Newsom Administrations that the California mega-fires of 2020 and 2021 did not wreak a comparable toll of death and destruction as did the Tubbs and Camp fires.





Challenge #2—It will require a tremendous effort to scale California's forest management to the joint State/Federal goal of one million acres treated/year by 2025, which is estimated to yield about 24M bone dry tons (BDT) of biomass per year.[8]

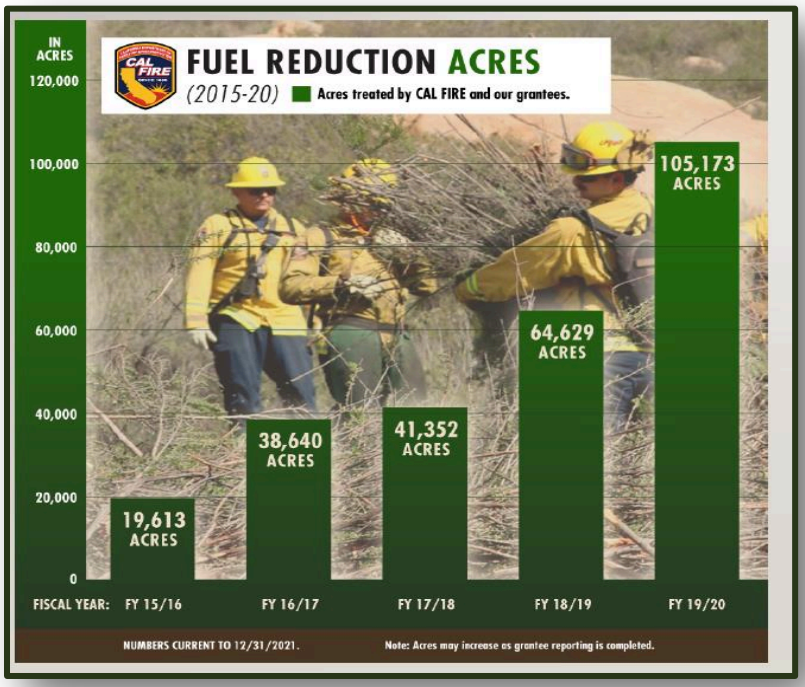
As stated by the US Forest Service in its Wildfire Crisis Strategy:

"Wildfires have been growing in size, duration, and destructivity over the past 20 years. Growing wildfire risk is due to accumulating fuels, a warming climate, and expanding development in the wildland-urban interface. The risk has reached crisis proportions in the West, calling for decisive action

[6] Governor Edmund G. Brown Jr., Executive Order B-52-18, at https://www.ca.gov/archive/gov39/wp-content/uploads/2018/05/5.10.18-Forest-EO.pdf
[7] CalFire Staff Chief Tim Robards, "The Urgency and Scope of the Problem," Presentation to the Department of Conservation's Forest Biofuels Gasification Pilot Program, (April 5, 2022).
[8] Getting to Neutral Report, at Table 8, p.31.

to protect people and communities and improve forest health and resilience. It will take a paradigm shift in land management across jurisdictional boundaries to reduce risk and restore fire-adapted landscapes.[9]

In order to achieve this dramatic expansion, California must sustain the rapid growth curve of forest treatment that has been established over the past five years.[10]



Challenge #3—The woody biomass fuels industry is in the early stages of commercialization and requires long-term favorable business conditions to meet the twin goals of establishing substantial demand for woody biomass feedstock and providing a reliable supply of low carbon bio-based fuels.

As has been demonstrated by the slow growth of the cellulosic ethanol industry, it is technically challenging to convert cellulosic materials including wood into liquid fuels. While there are multiple technologies that have now proven capable of converting woody biomass to transportation fuels, the woody biomass fuels industry is currently in scale-up mode.[11] The available technologies require high capital expenditures (CapEx) relative to the facility's annual production capacity. All of the companies

[9] Forest Service for the US Department of Agriculture, Confronting the Wildfire Crisis, at https://www.fs.usda.gov/sites/default/files/Confronting-Wildfire-Crisis.pdf at p. 3.
[10] CalFire Staff Chief Tim Robards, "The Urgency and Scope of the Problem," Presentation to the Department of Conservation's Forest Biofuels Gasification Pilot Program, (April 5, 2022).
[11] For insight into the current status of industry development, see the nine Company Profiles contained as an Appendix to this White Paper.

involved in the development of this White Paper have direct experience with this challenge. The policy recommendations presented here are all principally directed at overcoming this central challenge.

The solution to these challenges is to craft policy solutions that remove current barriers and enable the rapid scale-up of the industry:

Permitting—California imports 90% of its liquid low carbon fuels not just because it has limited feedstocks, but also due to State's uncertain and lengthy permitting process.

Revenue—California's Low Carbon Fuel Standard (LCFS) and the federal Renewable Fuel Standard (RFS) are the most important fuel policies because each program provides long-term predictable revenue that enables return on investment (ROI) and thereby attracts investment for CapEx. Both the LCFS and RFS currently contain policy flaws impeding revenue. These flaws can be fixed by regulatory action.

Feedstock—The industry requires reliable, long-term sources of feedstock at predictable pricing. Since National Forests are at high risk, woody biomass from National Forests must be an eligible feedstock.

Appropriations—In concert with the other policy recommendations, sustained and strategic state and federal funding over the next decade will accelerate the scaling of the industry.

SUMMARY OF RECOMMENDATIONS

The California Woody Biomass Policy Consortium ("Consortium") is composed of nine companies engaged in the development, commercialization and deployment of advanced technologies that convert woody biomass into low carbon transportation fuels ("industry"). Through this White Paper, the Consortium seeks to share with policymakers the potential of this industry to expand rapidly to simultaneously create demand for woody biomass generated by wildfire risk reduction programs and increase the supply of low carbon transportation fuels. The growth forecasts in this White Paper are premised upon the approval and implementation of four critical policy measures:

1. Update California State Policy

The California Air Resources Board (CARB) in concert with CalFire to utilize its existing regulatory authority to modify the LCFS to recognize the massive release of greenhouse gas and criteria pollutant emissions now resulting from California wildfires, prescribed burns, and citizen open burning, and to take action to reduce those emissions by providing avoided GHG emission credits within the CA-GREET model for fuels produced from qualifying woody biomass gathered from areas at risk of wildfire and open burn areas.

2. Support Revisions to Federal Policy

The U.S. Environmental Protection Agency (EPA) to utilize its existing regulatory authority to modify the RFS to recognize the peril of wildfires in the National Forests of the western U.S., and to take action in concert with the U.S. Forest Service to reduce that peril by authorizing RFS credit generation for fuels produced from qualifying woody biomass gathered from areas at risk of wildfire.

3. Expedite State Permitting

The California Legislature to pass legislation to facilitate state agency coordination and priority review of permits for facilities that produce fuels from qualifying woody biomass.

4. Direct Appropriations

To achieve the targeted growth of the industry, the California and federal governments should appropriate matching funds throughout the 2020s totalling one billion dollars to place the industry on track to create demand for 20 million bone dry tons of woody biomass in California by 2030. Particularly in the early years, a substantial portion of these funds should be dedicated to expanding staff capacity and resources at relevant departments and agencies.

DETAILED POLICY RECOMMENDATIONS

Background: The Consortium expresses its gratitude for the diligent work of the Forest Biofuels Working Group that was convened by the California Board of Forestry and Fire Protection and the Joint Institute for Wood Products Innovation, and that developed the comprehensive Forest Biofuels Report.[12] The authors of the Forest Biofuels Report engaged a 50-member working group on "Advancing collaborative action on forest biofuels" to promote policy and market development for forest biofuels across California. The diversity of experts in the working group allowed cross-pollination of ideas and opportunities across sectors, engagement of community members and practitioners capable of implementing recommendations directly.

The Forest Biofuels Report provided the starting point for this White Paper, and the Summary for Policymakers contained in that report is replicated here in its entirety as an Appendix to this White Paper. The Summary provides an excellent analysis of California's critical forest wildfire problem and the potential solution that a vibrant forest biofuels industry could deliver to the State, its residents, and its forests. We also thank the principal authors of the Forest Biofuels Report, Dr. Daniel Sanchez and Dr. Haris Gilani of the University of California, Berkeley, for their close collaboration in the development of this White Paper and in particular the modeling work that underlies the Industry Forecast section.

Due to the fact that the recommendations from the Forest Biofuels Report were the product of a collaborative effort with extensive input from policymakers, industry members, non-governmental organizations, technical experts, academics, and other stakeholders, the following two recommendations have been integrated into this White Paper without modification to preserve the full benefit of that input.

1. LCFS Recommendation

CARB should undertake the following actions related to the LCFS program:

- Support research and adopt a simplified forest biomass feedstock calculator for CA- GREET which estimates emissions savings from mobilizing in-state woody wastes and residues relative to the counterfactual fate of these feedstocks.
- Consider additional, targeted incentives for fuel pathways making use of in-state woody wastes and residues from fire management and forest restoration activities, such as credit carve-outs.
- Support research to quantify upstream and process emissions stemming from in-state forest restoration activities as well as other environmental and public health benefits.

2. RFS Recommendation

The EPA should undertake the following administrative actions related to the RFS program:

- Revise definitions as contained in Title 40, Section 80.1401 (Renewable Fuel Standard) of the Code of Federal Regulations as follows:
  - **Areas at risk of wildfire:** By wholly revising this definition, as "Areas at risk of wildfire are

[12] Joint Institute for Woody Products Innovation, California Board of Forestry and Fire Protection, posted in 2022 Reports, website at https://bof.fire.ca.gov/board-committees/joint-institute-for-wood-products-innovation/ , report at https://bof.fire.ca.gov/media/mn5gzmxv/joint-institute-forest-biofuels_final_2022_ada.pdf

determined on an ongoing basis by the government agency with primary authority for managing wildfire risk, including the United States Forest Service, other federal agencies, tribal authorities, and state and local fire agencies. Eligible renewable biomass can be gathered from areas at risk of wildfire so long as the biomass is obtained in compliance with an approved wildfire risk management activity approved by the responsible government agency."

- **Renewable biomass:** By partly revising paragraph (5), as "Biomass obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure including access roads and utility lines, at risk of wildfire."
- **Slash:** By partly revising this definition, as "Slash is the residue including treetops, branches, and bark, left on the ground after logging or accumulating as a result of a storm, fire, delimbing, or other similar disturbance, as well as whole dead or dying trees determined by the government agency with primary authority for managing wildfire risk to provide limited ecological benefit and otherwise create a high wildfire risk".

- Develop new guidance that outlines a pathway for sawmill residues from sawmills that purchase some non-qualifying wood and therefore incur a blanket disqualification under the RFS, to qualify as renewable biomass under the RFS through the use of inventory accounting methods that provide RIN crediting for the portion of the finished fuel that has been produced from qualifying renewable biomass.

SUPPLEMENTAL POLICY RECOMMENDATIONS

Supplemental Policy Recommendations: In addition to endorsing the LCFS and RFS Recommendations contained in the Joint Institute's Forest Biofuels Report, the California Woody Biomass Policy Consortium has identified the following two additional policy measures as critical to rapid industry growth.

3. California Legislature and State Agencies to Establish and Implement Mechanisms to Expedite State Permitting

The California Legislature to pass legislation to facilitate state agency coordination and priority review of permits for facilities that produce fuels from qualifying woody biomass.

It is well-known that siting industrial facilities in California present substantial permitting challenges. This is driven by California's extensive regulatory protections that include stringent protections for air, water and soil; demanding process requirements; and increasing recognition of the need to protect local communities and enhance environmental justice. The Consortium recognizes the vital importance of these objectives and does not recommend weakening the protections. However, due to the urgent and recurring risk of wildfire and open burning to human life, property, air quality and wildlife flora and fauna, there is strong impetus for the State to expedite the review and permitting of facilities to better mitigate these risks. This can be achieved by enhancing inter-agency coordination and expediting permit review for qualifying facilities with advanced technologies that utilize woody biomass to produce transportation fuels.

The following summary of best practices provides concrete examples of how California and other states have facilitated agency coordination and priority review of qualifying facilities, all of which should be applied to the permitting of facilities utilizing woody biomass to produce transportation fuels:

- Form interagency partnerships, coordinate agency reviews, set joint-agency working groups, and

publish model agency decisions. See the California Governor's Office of Business and Economic Development, Hydrogen Station Permitting Guidebook

- Launch permitting first through efficient pre-application meetings – as an example, see the Oregon Regional Solutions Program Overview
- Develop programs and initiatives to facilitate industry expansion – examples from the Indiana Economic Development Corporation include:
    - Regulatory Affairs
    - Opportunity Zones
    - Technology Parks
- Provide a central resource site for exploring incentives: Nevada Governor's Office of Economic Development)

4. California and Federal Legislature and Agencies to Direct Appropriations to Support Robust Industry Expansion to Create Demand for Woody Biomass and Supply of Low Carbon Fuels

To achieve the targeted growth of the industry, the California and federal governments should appropriate matching funds throughout the 2020s totaling one billion dollars to place the industry on track to create demand for 20 million bone dry tons of woody biomass in California by 2030. Particularly in the early years, a substantial portion of these funds should be dedicated to expanding staff capacity and resources at relevant departments and agencies.

The final recommendation of the California Woody Biomass Policy Consortium is the development of a long-term plan for both federal and state appropriations for the industry. In order to achieve the target of creating demand for 20 million BDTs of woody biomass in California by 2030, the Consortium determined that approximately one billion dollars in funding would be required in the 2020s. This would include both federal and state funding streams. Specific to facility financing, Consortium members agreed that a modest 5% level of CapEx support would enable more companies to benefit from grants, grow more capacity, and not cause the market distortions likely to result from larger grants to fewer companies.

In the short term, the Consortium recommends the rapid expansion of agency capacity. To meet the daunting new challenge of prolonged and extreme wildfire risk necessitates the development of a well-resourced, efficient, and innovative network of agencies. This network will plan and supervise a comprehensive program of forest management activities coupled with the rapid expansion and growth of the woody biomass to the transportation fuels sector. Additional staff capacity within state government is crucial to enable the inter-agency coordination that will be necessary for success. These efforts will be limited by a lack of dedicated staff focused on this issue, therefore, the State Legislature and Administration should ensure that additional staff capacity is hired and resources are made available to the relevant departments, boards, and agencies that are crucial to the effort (CalFire, Department of Conservation, Energy Commission, GoBiz, CARB, etc). Due to the dominance of National Forests in California, it will also be necessary for California and the federal government to establish permanent frameworks to enable close planning and coordination between California and the relevant federal agencies (US Forest Service, US EPA, etc.).

INTERDEPENDENCE OF THE POLICY RECOMMENDATIONS

To rapidly scale the industry, each of the four policy recommendations must be implemented. The LCFS and RFS programs provide substantial supplemental revenue streams for the production of low carbon transportation fuels, fundamentally changing the economics of converting woody biomass to fuel and significantly advancing GHG emissions reduction while creating a sustainable market that supports wildfire risk reduction. Until the economics of converting woody biomass to fuel are favorable for investors, growth will be slow-going and will require government support. Once favorable returns are achieved, private investment will flow into the sector.

The regulatory changes proposed in this White Paper would address distinct major limitations that prevent the use of woody biomass for low carbon transportation fuels. Specific to the LCFS, CARB has not yet recognized the GHG value of avoided wildfires, burn piles or open burning in its CA-GREET model and has thereby undercut the program's effectiveness to drive demand for woody biomass. The current regulatory language of the RFS effectively excludes biomass from national forests from being an eligible feedstock for transportation fuels, thereby precluding the most valuable federal low carbon fuels program from creating market demand for biomass from necessary forest treatments. Turning to permitting, California's long-wait times, complexities and uncertainties have caused several of the world's leading low carbon fuel producers to build facilities in neighboring states. However, due to the high cost of transporting woody biomass, and in order to derive maximum benefit and commercial value from forest management activities, California needs to have distributed facilities in-state rather than elsewhere. In order to achieve this goal and to attract jobs and economic development to the State, California must address its permitting timeline. Finally, long-term appropriations of state and federal dollars will speed industry expansion by creating new agency capabilities to address the extreme risk of wildfire and by establishing funds that facilities can use for capital expenditures.

Significant industry expansion in support of both GHG reductions and wildfire protection could be achieved by implementing the four recommended policies. The next section of this White Paper describes the anticipated transformation and decarbonization of California's transportation sector that successful implementation of these policies would achieve.

FORECASTED INDUSTRY GROWTH WITH IMPLEMENTATION OF POLICY FRAMEWORK

Adoption and implementation of the four policies recommended by this White Paper are projected to enable the expansion of the industry rapidly to create 20 M BDT of demand for woody biomass in California by 2030. This section of this White Paper describes the methodology and factors underlying the modeling of industry expansion. This modeling is largely consistent with the approaches taken in the Lawrence Livermore National Laboratory's Getting to Neutral Report and the Joint Institute's Forest Biofuels Report. In addition to the work of Dr. Sanchez and Dr. Gilani, this section benefits from the extensive work that CARB has done in evaluating the diversification of fuel supply that has been achieved to date in California due to the network of vehicle and fuel policies that the State has developed. Through the LCFS, Scoping Plan and other proceedings, CARB has scoped the anticipated transformation of California's transportation sector.

In particular, we use measures of different scenarios laid out by CARB in their illustrative compliance scenario calculator[13] (ICS) to quantify the total investment needed to scale up the forest biofuels industry in California. The ICS estimates fuel supply and credit generation scenarios for the LCFS to 2030. The CARB illustrative compliance scenarios for 2030 assume that 90-100% of natural gas supply to Californian transportation will be renewable by 2030, and forecasts 11.9 billion gallons of gasoline, 2 billion gallons of diesel and 319 million diesel gallons equivalent (DGE) of natural gas consumption by 2030 (Table 1).

Table 1: 2030 market size with capital cost of forest biofuels facilities

Fuel	Units	2030 market size	% share forest biofuels	Capacity in 2030	Facility size	Number of facilities	Capital cost (million$ / facility)	Total capital cost
Ethanol	**mm gal**	1,418	25%	354	40	9	500	4,500
Gasoline	**mm gal**	11,906	5%	595	100	6	1000	6,000
Renewable Natural Gas	**mm DGE**	319	25%	79	50	2	750	1,500
Diesel	**mm gal**	2,023	10%	202	100	2	1000	2,000
Alternative Jet Fuel	**mm gal**	225	50%	112	50	2	750	1,500
Hydrogen	**mm kg**	43	50%	21	3	7	100	700
Electricity	**1000 MWH**	7,576	10%	757	140	5	150	750

[13] California Air Resources Board, LCFS Regulation page at https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-regulation , see Low Demand Scenario; Supply Scenario:Project/LD/Low ZEV/20%/infra, at https://www.arb.ca.gov/fuels/lcfs/2018-0815_illustrative_compliance_scenario_calc.xlsx

Using the forecasted market size in 2030, we estimated the percentage share of forest biofuels to be between 5% and 50% across different fuel types. Biofuels such as hydrogen and Sustainable Aviation Fuels from forest biomass may have a higher penetration of up to 50% in the existing fuel markets compared to gasoline or diesel where forest biofuels could contribute up to 5% and 10% respectively. By calculating the capacity in 2030 and facility size for each fuel, we estimated the total number of biofuels facilities in California to be 33. We estimated the capital cost for each facility type by reviewing previous literature and in consultation with the technology providers and financiers. Based on capital cost estimates, we modeled the 5% cost share proposed in the Recommendations of this White Paper and calculated the proportion of the total expenditure ($847 million), resulting in federal and state contributions of $423 million each. Using woody biomass conversion factors (Shelly 2007), we estimated the total biomass utilization to be 20 million bone dry tons per year in California's forest biofuels sector.

SUMMARY FOR POLICYMAKERS FROM THE JOINT INSTITUTE FOR WOOD PRODUCTS INNOVATION'S FOREST BIOFUELS REPORT

The following is an excerpt from the California Joint Institute for Wood Products Innovation's 50-member working group on "Advancing collaborative action on forest biofuels" to promote policy and market development for forest biofuels. ("Forest Biofuels Report").[14]

Low-carbon and carbon-negative fuels from non-merchantable forest biomass can help California attain its greenhouse gas (GHG) reduction targets and offer an opportunity to support sustainable forest restoration activities to reduce wildfire risk. Development and deployment of these innovative wood products can help the state of California increase the pace and scale of forest restoration efforts, strengthen regional capacity, support innovation, reduce vulnerability to wildfire, and promote carbon storage in long-lived products, including geologically sequestered CO2. These fuels can also play a pivotal role in California's world-leading ambition to address climate change.

Yet successful commercialization of low- and carbon-negative fuels from forest biomass is far from certain, despite existing policy support. Fundamental challenges relate to the inability to secure long-term feedstock contracts from public lands, exclusion of forest biomass from public lands under the federal Renewable Fuels Standard, supply from municipal and agricultural biomass markets, and a lack of biofuels infrastructure situated near California's forested communities.

Without meaningful effort from relevant state and federal policymakers, California risks missing the opportunity to develop and deploy these fuels.

We engaged a 50-member working group on "Advancing collaborative action on forest biofuels"to promote policy and market development for forest biofuels across California. The diversity of experts in our working group allowed cross-pollination of ideas and opportunities across sectors, engagement of community members and practitioners capable of implementing recommendations directly.

We assessed four different fuel types that could be produced using non-merchantable forest biomass in California: hydrogen, ethanol, drop-in synthetic fuels that could displace gasoline, diesel or aviationfuel, and renewable natural gas (RNG).

The working group proposed several recommendations to enable low-carbon and carbon-negative forest biofuels pathways in a timely and sustainable manner, with strong environmental safeguards, and at a sufficient scale to support the state's ambitious goals.

Priority policy recommendations include:

- Catalyze first-mover projects with direct state support to demonstrate forest biomass supply

[14] Joint Institute for Woody Products Innovation, California Board of Forestry and Fire Protection, posted in 2022 Reports, website at https://bof.fire.ca.gov/board-committees/joint-institute-for-wood-products-innovation/ , report at https://bof.fire.ca.gov/media/mn5gzmxv/joint-institute-forest-biofuels_final_2022_ada.pdf

chains, creating a foundation for markets to scale.

- Update the federal Renewable Fuel Standard to reflect the modern-day threat of catastrophic wildfire in the American West
- Adopt changes in the state's Low Carbon Fuel Standard program to incentivize forest biofuels projects.
- Facilitate regulatory coordination and develop bold new policies to advance carbon dioxide removal as a climate solution.
- Establish and support new flexible, public regional entities to overcome barriers to long-term forest biomass feedstock supply.
- Support research into sustainability criteria for out-of-state projects and ensure that all forest biofuels supplied to California meet equally high environmental standards.
- Support biofuels and bioenergy project development & finance by creating a 'hub' that can convene stakeholders and share best practices across the technical, commercial, and financial aspects required for successful project development. Such a hub could be hosted within the Governor's Office of Business and Economic Development (GO-Biz).

As a state agency, it could double as a conduit for state aid to accelerate bioenergy development.

- Via the Catalyst Fund at IBank, provide strategic capital for critical infrastructure aligned with state goals for the sector, while supporting economic development in forested communities.
- California's 2021-2022 budget makes critical initial investments in realizing this vision through investments in the Catalyst Fund and a Forest Biofuels pilot project.

Working Group members also emphasized the opportunities for forest biofuels to address socio-economic resilience and to reduce climate and wildfire vulnerability for rural and forested communities in the state. Priority recommendations to enable equity and development alongside forest biofuel industry growth include:

- Ensure consistency with the Governor's All Regions Rise dictum.
- Accurately capture rural forest community conditions and vulnerability status, via improved tools and definitions built to specifically and exclusively guide non-California Climate Investments (CCI) state monies directed at forest biofuels and forest restoration in California.

Existing definitions of 'underserved' in the state of California do not effectively target those communities which are disproportionately impacted by wildfire, forest biofuels use, and by sustainable forest restoration. This causes associated funds and regulatory measures to ineffectively address the climate and wildfire vulnerability and socio-economic resilience of these communities.

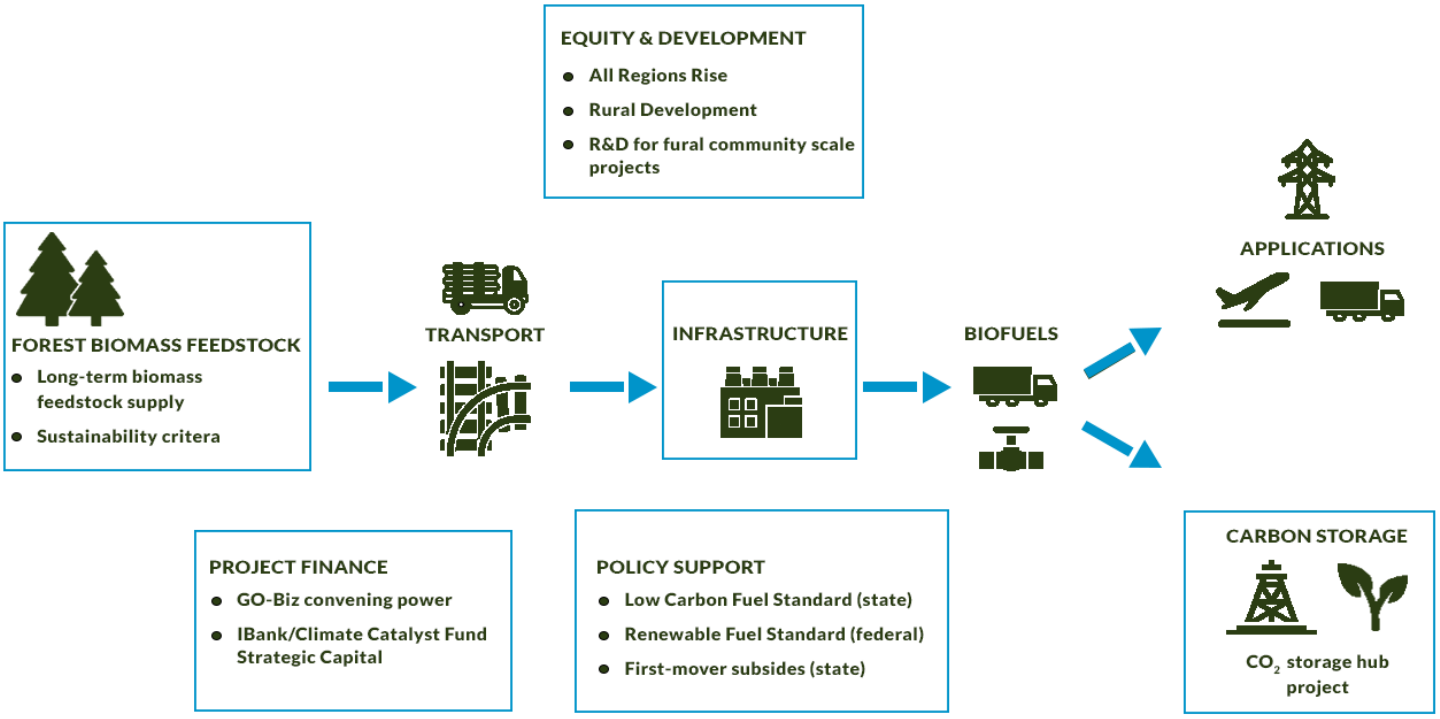
Two pathways to address this include:

(a) develop a specific definition of 'underserved' – solely for the purpose of guiding non- CCI state monies which target forest biofuels and forest restoration.
(b) Improve mapping tools and data accuracy to enable consideration of underserved communities under thisnew definition.

- Direct public investments in ways that aim to achieve sustainable water shed, forest and community benefit.
- Allocate public funds to demonstrate rural, community-scale hydrogen. There are significant anticipated benefits of such a model, including rural energy security, replacement of fossil fuels in rural and Tribal lands, and rural economic resilience.

FIGURE 1:

This figure summarizes the areas of interventions with related recommendations identified in this report that are necessary to catalyze a carbon-negative forest biofuels supply chain in California.



California Woody Biomass Policy Consortium
Company and Project Profiles

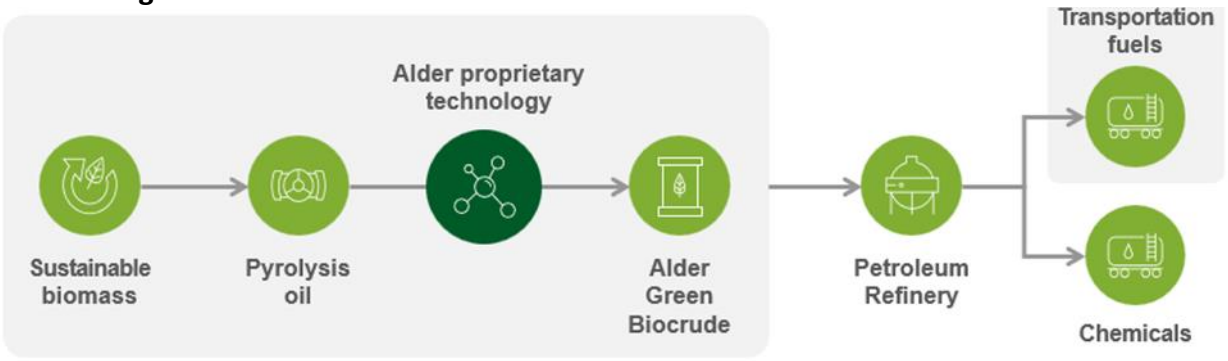
Company Name: Alder Fuels

Website: www.alderfuels.com

Date Founded: 2019

Brief Description of Technology:
Alder Fuels solution maximizes the value of sustainable biomass by combining existing commercial scale processes with an elegant proprietary step to link together a complete solid biomass to liquid renewable fuel technology. The first step is converting sustainable biomass into liquid pyrolysis oil through existing technology utilized currently across North America and Europe. The second step is Alder's proprietary process to convert pyrolysis oil into separate streams including a high value green biocrude that can be sent to a petroleum refinery. The third and final step is sending the Alder green biocrude to an existing petroleum refinery for hydroprocessing into liquid transportation fuels. This commonly occurs today at refineries across North America and Europe where petroleum and liquid bio-oils are co-processed into renewable diesel, gasoline, and aviation fuels.

Process Diagram:



Feedstocks Utilized:
Alder's technology is compatible with most types of cellulosic biomass, including forest slash and timber mill residuals, agricultural harvest residuals and purpose grown or regenerative agriculture energy crops.

Products Produced:
Alder's technology produced a low carbon biocrude which is suitable for conversion into sustainable aviation fuel (SAF), renewable diesel, and renewable naphtha.

Facilities in Operation

Name	
County	
State	
Country	
Status	
Scale and Number of Facilities	
Year of commissioning	

Facilities in Development

Name	**TBD**
County	TBD
State	TBD
Country	USA
Status	Site finalization
Scale and Number of Facilities	TBD
Targeted Year of commissioning	2024
Technology Readiness Level (TRL)	

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with optimal policy structure

Name	**TBD**
County	TBD
State	California
Country	USA
Status	Site Selection
Scale and Number of Facilities	TBD
Targeted Year of commissioning	2026
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	

California Woody Biomass Policy Consortium
Company and Project Profiles

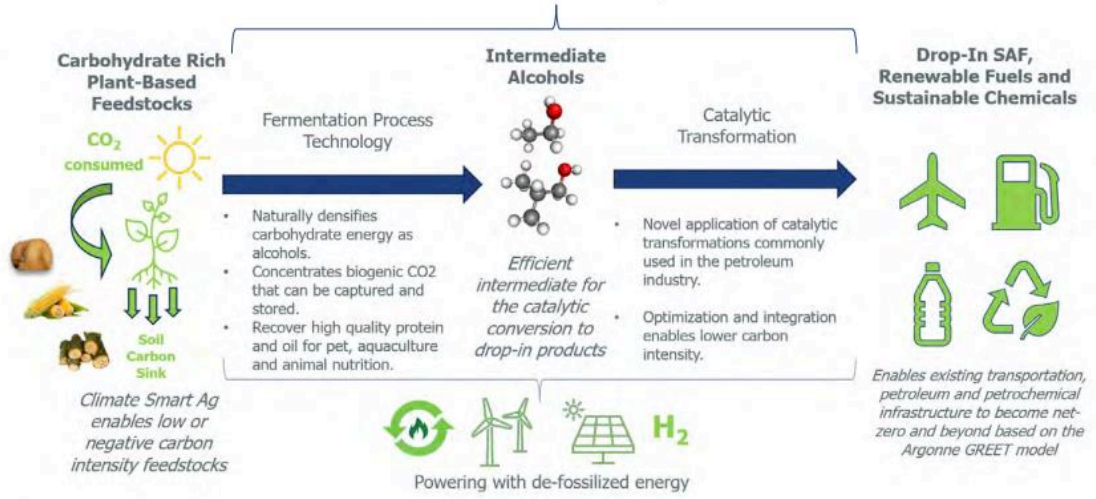
Company Name: Gevo, Inc

Website: www.gevo.com

Date Founded: 2005

Brief Description of Technology:
To make its energy-dense liquid hydrocarbons, Gevo uses low-carbon renewable resource-based carbohydrates as raw materials. It is also developing renewable electricity and renewable natural gas for use in its production processes, resulting in low-carbon fuels with substantially reduced carbon intensity. Gevo's proprietary technology can incorporate a variety of feedstock sources to produce fuel products.

Process Diagram:



Feedstocks Utilized:
Gevo technology utilizes regenerative agriculture energy crops such as field corn and is also compatible with most types of cellulosic and woody biomass, including forest slash and timber mill residuals and agricultural harvest residuals.

Products Produced:
Gevo's technology produces sustainable aviation fuel (SAF) and renewable gasoline. For fuel products that utilize field corn as a feedstock, high-value protein for pet nutrition and aquaculture is also produced.

Facilities in Operation

Name	Luverne, MN (Development Research Facility)
County	Rock
State	Minnesota
Country	United States
Status	Active
Scale and Number of Facilities	1.5 MGPY of IBA & 18MGPY of EtOH
Year of commissioning	Acquired for re-engineering 2010

Name	South Hampton Resources Facility in Silsbee, TX (Jet and Isooctane Biorefinery)
County	Hardin
State	Texas
Country	United States
Status	Active
Scale and Number of Facilities	100 KGPY
Year of commissioning	Operated in Partnership with South Hampton Resources, Inc. since 2011

Facilities in Development

Name	Net-Zero 1
County	Kingsbury
State	South Dakota
Country	USA
Status	In site finalization process
Scale and Number of Facilities	60MMGPY Hydrocarbon Plant Expected
Targeted Year of commissioning	2024
Technology Readiness Level (TRL)	

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with an optimal policy structure

Recent Press Release: **Gevo and Sweetwater Energy Sign MoU to Supply Lignocellulosic Feedstocks to Produce Cellulosic Alcohols and Sustainable Aviation Fuel**

Name	TBD
County	TBD
State	TBD
Country	USA
Status	Preliminary Feasibility and Site Selection
Scale and Number of Facilities	TBD
Targeted Year of commissioning	TBD
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	

California Woody Biomass Policy Consortium
Company and Project Profiles

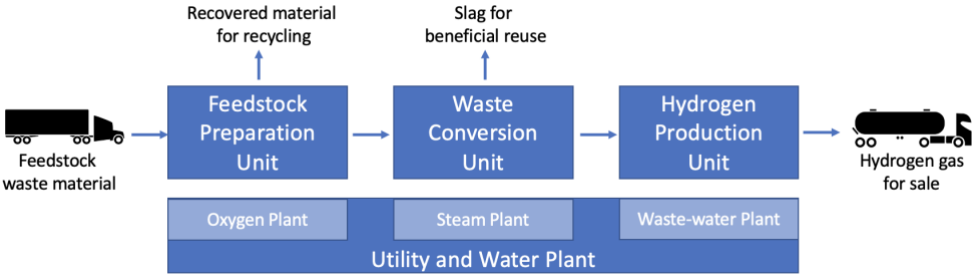
Company Name: H Cycle, LLC

Website: www.hcycle.com

Date Founded: 2020 (Technology provider founded in 2001)

Brief Description of Technology:
H Cycle utilizes a thermochemical conversion technology from Omnivorous Conversion Technologies ('OMNI'). The OMNI system converts organic feedstock to synthetic gas (syngas), which is a mixture comprised mostly of carbon monoxide and hydrogen. A regulated input of steam, oxygen and some natural gas are utilized in the conversion process. The syngas is convered and purified to hydrogen using conventional processes, utilized in a variety of industrial applications. The conversion process involves three stages: low temperature pyrolysis, followed by an updraft gasifier for the conversion of chars leftover from the first stage, and plasma reforming to convert final tars in the syngas produced from stage one and two into additional product. Inorganic material (e.g. metals, ash) is recovered as a non-leaching slag material.
Note: H Cycle is a project developer licensing the technology from companies specialized in the development and licensing of process technologies.

Process Diagram:



Feedstocks Utilized:
Post-processed municipal solid waste (focusing on organic fractions), biomass (agriculture and forest thinnings). Can handle a high degree of contamination (e.g. metals, plastics, glass) given the technology utilized

Products Produced:
Hydrogen; can also produce renewable natural gas and liquid fuels.
A non-leaching non-hazardous slag that can be sold as road base or used at higher value as construction aggregate or in the cement industry.

Facilities in Operation

Name	Plasco Trail Road
County	Ottawa
State	Ontario
Country	Canada
Status	Shutdown (commercial demonstration)
Scale and Number of Facilities	135 MTPD (1 facility)
Year of commissioning	2006 (shutdown in 2015)

Facilities in Development

Name	TBD
County	Contra Costa, Los Angeles, Central Valley
State	California
Country	USA
Status	Site finalization
Scale and Number of Facilities	200 MTPD (3x facilities)
Targeted Year of commissioning	2025 for first one, 2026 for the next two
Technology Readiness Level (TRL)	8

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with optimal policy structure

Name	TBD
County	TBD (likely Butte)
State	California
Country	USA
Status	Site Selection
Scale and Number of Facilities	200 MTPD (1 facility)
Targeted Year of commissioning	2028
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	8 (should be 9 by then)

California Woody Biomass Policy Consortium
Company and Project Profiles

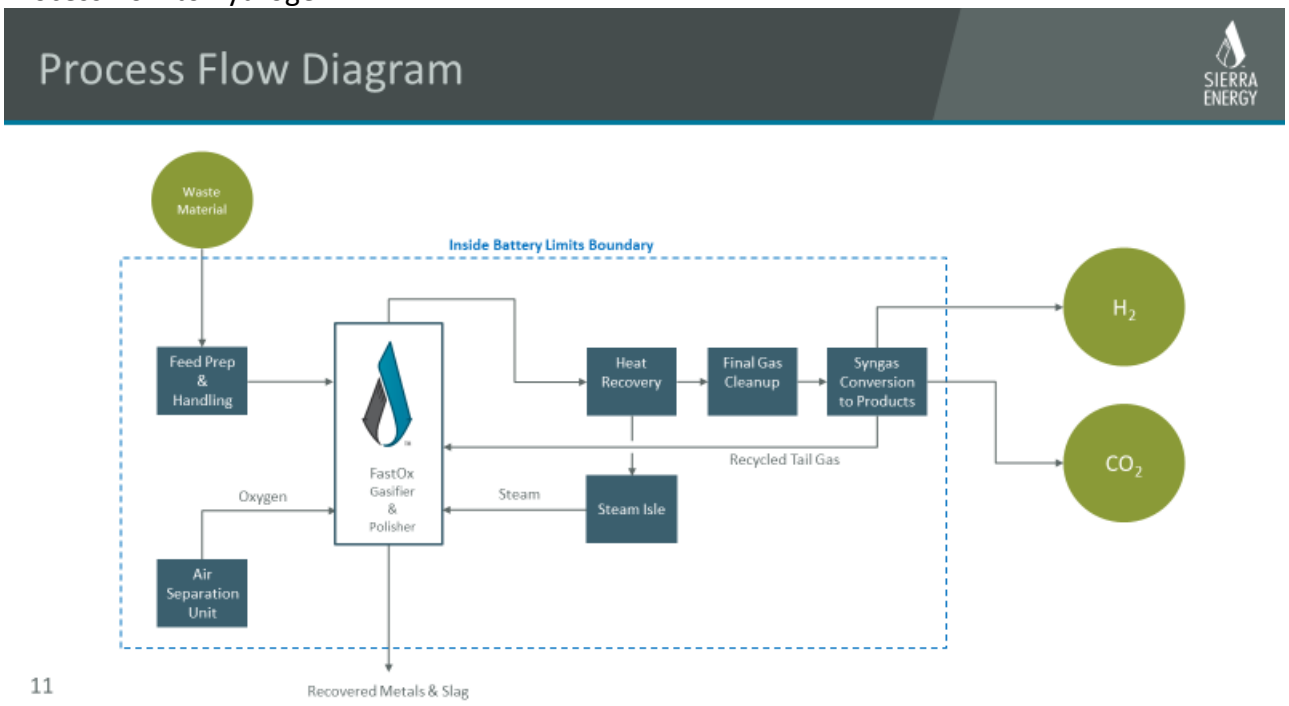
Company Name: Sierra Energy

Website: www.sierraenergy.com

Date Founded: 2004

Brief Description of Technology:
Sierra Energy's FastOx® gasification turns waste into hydrogen, renewable natural gas, methanol, and other high-value end-products without burning. FastOx gasification is an ultra-high temperature updraft gasifier that uses oxygen and steam to heat waste up to 4,000°F, where waste breaks down at the molecular level. Organic material is converted into synthesis gas that is then turned into a high-value end-product. Inorganic material is recovered as either a non-leaching stone or molten metal. All outputs are saleable and there are no toxic ash or waste by-products that need to be disposed.

Process Diagram:
Process flow to hydrogen.



Feedstocks Utilized:
Biomass and post-recycled municipal solid waste. (Note: due to our high temperature operations, we can also convert more difficult feedstocks such as tires, medical waste, e-waste, and some hazardous wastes.)

Products Produced:

Hydrogen, renewable natural gas, methanol, and other liquid fuels. We also produce a non-leaching stone that can be sold as road base or used at higher value as construction aggregate or in the cement industry.

Facilities in Operation

Name	**Ft. Hunter Liggett**
County	Monterey
State	California
Country	USA
Status	Operational
Scale and Number of Facilities	10 MTPD (1 facility)
Year of commissioning	2020

Facilities in Development

Name	**TBD**
County	Sacramento
State	California
Country	USA
Status	Site finalization
Scale and Number of Facilities	100 MTPD (1 facility)
Targeted Year of commissioning	2025
Technology Readiness Level (TRL)	8

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with optimal policy structure

Name	**TBD**
County	TBD
State	California
Country	USA
Status	Site Selection
Scale and Number of Facilities	200 MTPD (1 facility)
Targeted Year of commissioning	2027
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	8

Note: Sierra Energy is a licensor of gasification technology. As a technology vendor, we are partnering with project developers worldwide. While the bulk of the projects using our technology will be developed by others including outside the United States, we will, in some instances including those outlined above, build, own, and operate full systems ourselves.

California Woody Biomass Policy Consortium
Company and Project Profiles

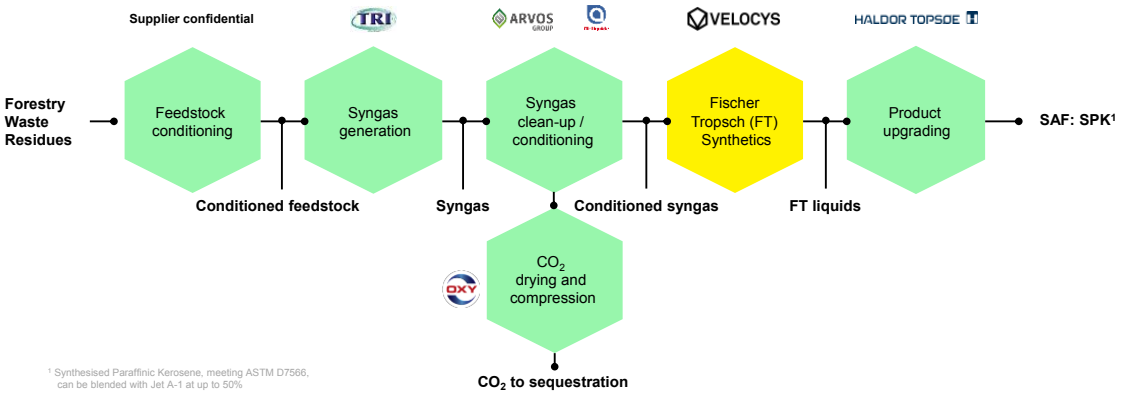
Company Name: Velocys, Inc.

Website: https://www.velocys.com/, https://www.bayoufuels.com/, and https://www.altalto.com/

Date Founded: 2001

Brief Description of Technology: Compact, efficient Fischer Tropsch technology. See https://www.velocys.com/technology/ for overview.

Process Diagram:



Feedstocks Utilized: Woody biomass, Municipal Solid Waste or other cellulosic materials

Products Produced: Sustainable Aviation Fuel, Renewable Diesel and Gasoline blendstock (naphtha)

Facilities that have operated

Name	**Envia Energy**
County	Oklahoma County
State	Oklahoma
Country	USA
Status	Completed operations
Scale and Number of Facilities	2.7 million gallons/year
Year of commissioning	2017

Facilities in Development

Name	Bayou Fuels
County	Adams
State	Mississippi
Country	USA
Status	Engineering
Scale and Number of Facilities	35 million gallons/year
Targeted Year of commissioning	2025
Technology Readiness Level (TRL)	8

Bayou Fuels Biorefinery – Natchez, MS

Name	Altalto
County	
State	Immingham
Country	UK
Status	Engineering
Scale and Number of Facilities	20 million gallons/year
Targeted Year of commissioning	2026
Technology Readiness Level (TRL)	8

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with optimal policy structure

Name	TBD
County	TBD
State	California
Country	USA
Status	Site Selection
Scale and Number of Facilities	35 million gallons/year (3)
Targeted Year of commissioning	2028 - 2030
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	8

California Woody Biomass Policy Consortium
Company and Project Profiles

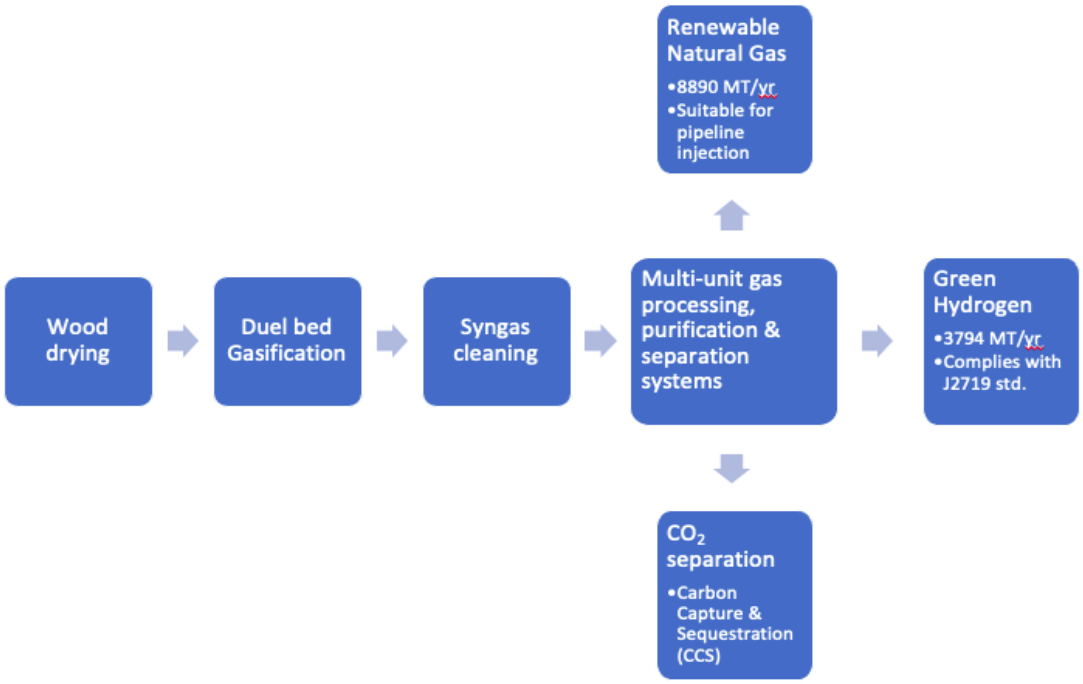
Company Name: Yosemite Clean Energy, LLC

Website: yosemiteclean.com

Date Founded: 2017

Brief Description of Technology: Biomass-gasification is a commercially proven technology that has been used on an industrial scale in Europe for nearly 20 years. The technology provider selected by Yosemite, Aichernig Engineering (or "Repotec"), has successfully commercialized dual-bed biomass gasification technology since 2003 and has developed plants around the world. Repotec is based in Vienna, Austria, and utilizes technology originally developed at the Vienna University of Technology. Yosemite will employ this technology to convert biomass into syngas, with downstream conversion to green hydrogen and RNG taking place using technologies widely commercialized in the United States, supplied by companies such as Air Liquide and Chart Industries.

Process Diagram:



Feedstocks Utilized: Forest and farm wood waste

Products Produced: Renewable Natural Gas, Green Hydrogen, CO_2 CCS

Facilities in Development

Name	Oroville Biofuels Plant
County	Butte County
State	California
Country	USA
Status	FEL3 Detailed engineering and permitting
Scale and Number of Facilities	90,000BDT, 31 tons RNG, 13 tons H2
Targeted Year of commissioning	2024
Technology Readiness Level (TRL)	9

Name	Tuolumne Biofuels Plant
County	Tuolumne County
State	California
Country	USA
Status	FEL3 Detailed engineering and permitting
Scale and Number of Facilities	100,000BDT, 31 tons RNG, 13 tons H2
Targeted Year of commissioning	2025
Technology Readiness Level (TRL)	9

Name	Visalia Biofuels Plant
County	Tulare County
State	California
Country	USA
Status	FEL3 Detailed engineering
Scale and Number of Facilities	100,000BDT, 31 tons RNG, 13 tons H2
Targeted Year of commissioning	2026
Technology Readiness Level (TRL)	9

Estimated Future Facilities that will access California forest biomass as feedstock that will be commissioned by 2030 with optimal policy structure

Name	Additional Yosemite Biofuels Plants
County	Multiple
State	California
Country	USA
Status	Early stage development
Scale and Number of Facilities	7 additional facilities. 100,000BDT, 31 tons RNG, 13 tons H2 per facility
Targeted Year of commissioning	2025 through 2030
Current Technology Readiness Level (TRL) of Full Scale Facility Targeted for Deployment by 2030	9