NOYES LAW CORPORATION
FUEL & CARBON LAW

May 10, 2024

Matthew Botill
Industrial Strategies Division Chief
California Air Resources Board

Comment submitted electronically

RE: Kore Infrastructure's Comments on the Importance of Low Carbon Intensity Power Sourcing to Achieving California's Wildfire Risk Reduction and Hydrogen Goals

Dear Mr. Botill:

This comment letter is submitted on behalf of Kore Infrastructure ("Kore") to provide input to the California Air Resources Board ("CARB") regarding how the LCFS regulatory amendments pertaining to power sourcing can facilitate achievement of California's critical goals of reducing wildfire risk and expanding hydrogen supply.

Kore's Modular Biomass to Hydrogen Technology

Kore is a world leading company utilizing high temperature, slow pyrolysis to convert organic feedstocks into an energy dense biogas and a solid carbon char through the deployment of shipping container sized modular units. Kore previously operated a 24 ton per day woody biomass to RNG modular facility at the SoCalGas Olympic Boulevard Site in Los Angeles.[1] As recently described in recent Forbes Magazine:

> *Kore Infrastructure has unveiled a collaboration with the Tule River Economic Development Corporation to address two critical challenges simultaneously—wildfire hazards and the decarbonization of transportation.*
>
> *This partnership, demonstrating a significant leap in Kore's commercialization, will employ indigenous workers from the Tule River Tribe to clear non-merchantable trees and brush from around power transmission lines then pyrolyzing that biomass at a Kore facility to produce carbon-negative hydrogen—a "deadwood-to-clean-energy" solution.*
>
> *Not only does this project reduce the risk of forest fires and provide carbon-free hydrogen, but it also offers employment opportunities to an underserved rural community.*
>
> *The hydrogen produced by Kore will be sold to Toyota Tsusho to power industrial vehicles like forklifts for its operations at the Port of Los Angeles.*[2]

[1] SoCal Gas, "SoCalGas Announces the Commission of Carbon-Negative Waste-to-Energy Technology at Low Angeles Facility," (July 20, 2022), at https://newsroom.socalgas.com/press-release/socalgas-announces-the-commissioning-of-carbon-negative-waste-to-energy-technology-at

[2] Eric Kobayashi-Solomon, in Forbes-Innovation-Sustainability, "Kore's Latest Project Cuts Fire Risk and Creates Green Hydrogen," (February 26, 2024), at https://www.forbes.com/sites/erikkobayashisolomon/2024/02/06/kores-latest-project-cuts-fire-risk-and-creates-carbon-negative-fuel/?sh=1eb431ba4153

NOYES LAW CORPORATION
FUEL & CARBON LAW

Kore's Tule River Economic Development and Wildfire Risk Reduction Project

As noted in the Forbes article, Kore Infrastructure has partnered with the Tule River Economic Development Corporation of the Tule River Tribe of California to develop a forest biomass to carbon negative hydrogen project on the Tule River Tribe reservation east of Porterville, CA. Kore's standard design, factory built, modular technology provided the right-sized platform for the Tule River Economic Development Corporation to develop a renewable energy campus at a prudent capacity, then scale to meet growing demand for carbon negative energy. This project will bring multiple benefits to the State and local community, including:

- Reducing wildfire risk in the Sierra Nevada Forest
- Decarbonizing California transportation with zero emission hydrogen
- Reducing atmospheric CO_2 through carbon sequestration
- Providing an opportunity to decarbonize cement manufacturing to meet SB 596 Low Carbon Cement Standards
- Creating new jobs and economic activity in an SB 535 Disadvantaged Community

The project will process 48 tons per day of woody biomass, primarily non-merchantable dead dying, and diseased trees removed from Sierra Nevada Forests to reduce wildfire risk. The Tule River Tribe currently manages 57,000 acres of Sierra Nevada Forest. Orchard wood waste from the Central Valley will provide supplemental feedstock when forest access is unavailable due to weather or other adverse conditions.

The project will generate two metric tons per day of fuel cell quality hydrogen (99.999% purity.) Toyota Tsusho will offtake this hydrogen for a project to decarbonize shipping container movement at the Ports of Los Angeles and Long Beach by converting diesel powered equipment to fuel cells. This hydrogen may also be available to local users as demand for fuel cell quality hydrogen increases. The project will also consider using fuel cell electric vehicles (FCEV) to transport feedstock, hydrogen, and biocarbon to reduce the project's carbon intensity.

The project will also generate about 10 tons per day of biocarbon, an elemental carbon coproduct with many beneficial uses. As a soil amendment, biocarbon increases plant yield while reducing irrigation water and fertilizer. Biocarbon also sequesters about 3 tons of CO_2 for every ton incorporated into the soil. And biocarbon has a heating value comparable to fossil coal, so it can be used to decarbonize difficult to decarbonize industries like cement manufacturing which accounts for 4-percent of California's greenhouse gas (GHG) emissions.

The Porterville area where this facility will be located is an SB 535 Disadvantaged Community. The project will bring over a dozen jobs and increased economic activity to this community.

This is the first phase of a project that is being master planned to triple in size, increasing the GHG benefits and adding additional jobs and economic activity. The Tule River Economic Development Corporation is also considering replicating this model for several other projects throughout the Central Valley.

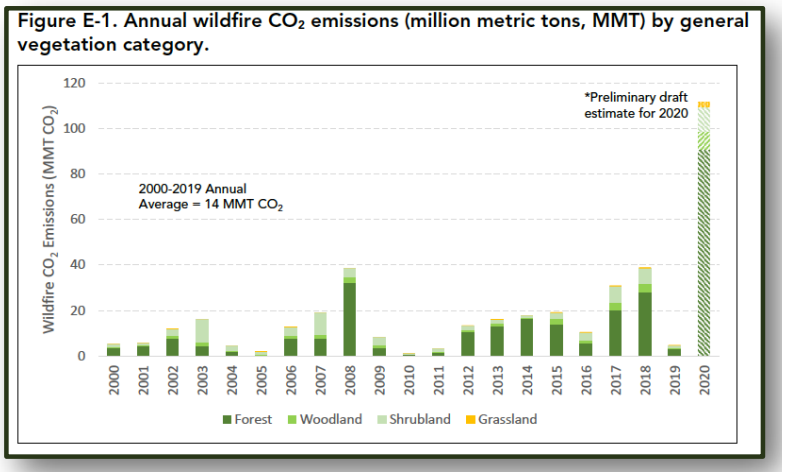
NOYES LAW CORPORATION
FUEL & CARBON LAW

Woody Biomass from Wildfire Risk Reduction is an Ideal Feedstock for Hydrogen in California

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

> **Convert Waste Biomass to Fuels and Store CO2**
>
> *"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 CO2 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]

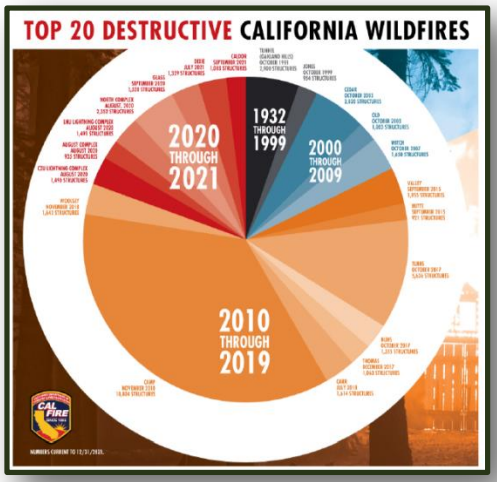
As a result of the changed conditions in the forests coupled with climate change, California's forests have changed from a carbon sink to a carbon source. Wildfires nationwide have drastically increased in intensity and frequency in recent years, creating not only increasing risk to life, health and property but also generating substantial GHG emissions to exacerbate the effects of climate change.[4]



[3] Sarah E. Baker, Joshuah K. Stolaroff, George Peridas, et al, 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, "California Wildfire Emission Estimates," at https://ww2.arb.ca.gov/wildfire-emissions, see "Public Comment Draft: GHG Emissions of Contemporary Wildfire, Prescribed Fire, and Forest Management Activities," at p. i, available at https://ww2.arb.ca.gov/wildfire-emissions

The national trend is particularly acute in California. 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 as is reflected by these slides presented by former CalFire Staff Chief Tim Robards.[5]



The LCFS Carbon Intensity Score for Kore's Hydrogen Pathway Will Materially Influence the Economic Viability of Kore's Facilities

The focus of the LCFS program structure is to reduce the CI of transportation fuels in California. Kore has not yet operated a modular facility at steady state operation for a calendar quarter as is necessary to provide sufficient data to support a provisional LCFS pathway application. Therefore, in lieu of a Kore-specific pathway score, this comment relies upon an analysis of the typical carbon intensity performance of technologies capable of converting woody biomass to hydrogen, including pyrolysis. Please see attached analysis entitled "Carbon Negative Biomass Options- Electric Power Implications," prepared by Stefan Unnasch of Life Cycle Associates, LLC attached as **Exhibit A** (hereafter "Pyrolysis LCA Analysis").

As is established by the Pyrolysis LCA Analysis, the critical factor that essentially determines the CI of hydrogen produced from woody biomass by pyrolysis is grid electricity. The total calculated CI is 54.2 with 47.5 of this amount (88%) resulting from grid electricity input.[6] As one would expect, the opportunity to source zero CI power from wind, solar or another qualifying source drops the CI score to 6.7.[7] While not the focus of this comment, an even more favorable CI score is established if the carbon storage benefit that the co-product of biochar is recognized. Under the zero CI electricity plus carbon storage recognition of pyrolysis, the CI score would be -172 gCO_2e/MJ.

---

[5] Former 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), as referenced by Graham Noyes, Alfredo Arredondo, Haris Gilani, Dan Sanchez, Robin Vercruse, Turning Wildfire Tinder Into Low Carbon Fuels (May 2022), at https://yosemitestanislaussolutions.com/wp-content/uploads/2022/05/Turning-Wildfire-Tinder-Into-Low-Carbon-Fuels_White-paper-for-Policymakers.pdf , at p. 4, footnote 7.

[6] See Exhibit A, at Table 1, at p. 1.

[7] Id. at Table 2, at p. 4.

For the following calculations, we will use the pyrolysis to hydrogen grid mix score of 54.2 rounded to 54, the zero emission electricity score of 6.7 rounded to 7, and the combined zero emission electricity and carbon storage score of -172 $gCO2_e/MJ$. CARB's LCFS Dashboard provides a credit calculator that is an excellent tool for determining the value of LCFS credits based on user inputted values for compliance year, LCFS credit price, CI score, vehicle utilized, fuel displaced, and other factors.[8] Kore plans to focus on the heavy-duty vehicle market to support the short-haul trucking of woody biomass to its facilities by hydrogen truck FCEVs so the following calculation is based on: the compliance year of 2025, reference fuel of diesel, vehicle-fuel EER of 1.9, and fuel equivalency of dollars per kilogram of hydrogen. The LCFS credit prices used are low ($50/MT), medium ($150/MT), and high ($250/MT). Utilizing these parameters yields the following credit values per kg hydrogen, premium values for lower CI fuel, and increased revenues per year and over 15-year return on investment period.

CI Score	**$50/MT**	**$150/MT**	**$250/MT**
54	$.66	$1.99	$3.32
7	$.95	$2.84	$4.73
Premium Value	$.29	$.85	$1.41
Annual Premium Value @ 730 MT/yr	**$211,700**	**$620,500**	**$1,029,300**
Premium Over 15 Year Return on Investment Period	**$3,175,500**	**$9,307,500**	**$15,439,500**
CI = -172	$2.02	$6.06	$10.10
Premium Value (-172) vs. CI Score of 54	$1.36	$4.07	$6.78
Annual Premium Value @ 730 MT/yr	**$992,800**	**$2,971,100**	**$4,949,400**
Premium Over 15 Year Return on Investment Period	**$14,892,000**	**$44,566,500**	**$74,241,000**

As demonstrated in the prior analysis, the LCFS regulatory structure pertaining to Low-CI power sourcing has a material impact on the financial performance of a KORE facility by altering the revenue stream that the LCFS programs provides to low carbon fuel production facilities that supply qualifying transportation fuels to California including hydrogen. While the total amount of revenue varies across the low, medium and high market scenarios, all three scenarios are highly significant in a commodity fuel market that trades fuel on basis points rather than pennies. An additional revenue stream of $0.29 to $6.78 per kilogram of fuel produced can swing a marginal project to profitably thereby attracting debt and equity investment that would otherwise not participate. KORE's standard design, factory-assembled, skid-mounted facilities are capital-light projects as compared to other pyrolysis facilities due to their modular nature. The modular design allows the technology to be situated in remote areas, including in or adjacent to California

[8] CARB, "LCFS Data Dashboard," Credit Value Calculator available for download via Figure 7 link, at https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard

forests. KORE facilities are long-term investments that may not provide a full return on investment prior to a 15-year period. However, once the capital expenditure for the facility is recovered, the opportunity to make fuel from woody biomass cleared from forest management is a highly attractive one.

Over that 15-year period, the ability of a KORE plant to source zero-CI power will deliver **$3,175,500** in additional revenue in a low LCFS market, **$9,307,500** in a medium LCFS market, and **$15,439,500**in a high LCFS market. It is for this reason that low carbon fuel producers like KORE are keen to access the Low-CI power market.

Over the same 15-year period, the ability of a KORE plant to source zero-CI power and have its biochar recognized as sequestered carbon will deliver **$14,892,000** in additional revenue in a low LCFS market, **$44,566,500** in a medium LCFS market, and **$74,241,000** in a high LCFS market. It is for this reason that low carbon fuel producers like KORE are keen to access the Low-CI power market.

Optimal California Policy for Hydrogen Power Sourcing Will Maximize Federal Funding to California and Speed Decarbonization

In this LCFS rulemaking, CARB can and should enable hydrogen producers to source Low-CI Power through a viable book-and-claim accounting mechanism. Kore supports the comments of the hydrogen production industry on these issues, and encourages CARB to continue to engage with the leadership of ARCHES to identify the optimal structure to integrate into the LCFS regulation with recognition of California's unique protections that guard against resource shuffling.

Through this regulatory strategy, CARB will achieve upstream emission reductions and stimulate expansion of Low-CI power generation capacity, storage and transmission during the peak spending period of IRA and Infrastructure Investment and Jobs Act ("IIJA").

As stated in a Brookings Institute Report issued on February 1, 2023:

> *Between the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), the 117th Congress invested $1.25 trillion across the transportation, energy, water resources, and broadband sectors for the next five to 10 years. It's now the Biden administration's responsibility to get that historic amount of money out the door—yet the bulk of it is still sitting in federal coffers or unrealized tax credits on the federal balance sheet.* [9]

As highlighted by the Brookings Institute Report, taken as a whole, the IIJA and IRA will deliver well over a trillion dollars to the U.S. economy over the period of a decade. It is a substantial undertaking for the federal government to establish the necessary programs, program structures, eligibility requirements, application process, and oversight for the programs. The IIJA was

[9] Adie Tomer, Caroline George and Joseph W. Kane for Brookings Research, "The start of America's infrastructure decade: How macroeconomic factors may shape local strategies," at https://www.brookings.edu/articles/the-start-of-americas-infrastructure-decade-how-macroeconomic-factors-may-shape-local-strategies/

signed into law on November 15, 2021,[10] and the IRA was signed into law on August 16, 2022.[11] However, according to a comprehensive analysis released on May 8th by Politico, only a small slice of the funds have been spent. According to Politico:

- *Less than 17 percent of the $1.1 trillion those laws provided for direct investments on climate, energy and infrastructure has been spent as of April, nearly two years after Biden signed the last of the statutes.*
- *Out of $145 billion in direct spending on energy and climate programs in the Inflation Reduction Act, the biggest climate law in U.S. history, the administration has announced roughly $60 billion in tentative funding decisions as of April 11. (...)*
- *And only $125 billion has been spent from the $884 billion provided by the infrastructure law and the pandemic law, both of which Biden signed in 2021. Roughly $300 billion of that won't be legally available to spend until the next two fiscal years. (...)*
- *The IRA also unleashed a gusher of private company investments in clean energy and manufacturing by offering a series of tax breaks that, based on recent estimates, are worth at least $525 billion.*

As noted by Politico, "Now time is running short for these efforts to show results before voters decide whether to bring back Trump, who has denounced the climate and infrastructure laws, mocked wind power and electric cars and inaccurately described the IRA as the "biggest tax hike in history."[12]

Kore is a Phase I Recipient of Funding
Through the Carbon Negative Biofuels Program for the
Tule River Economic Development and Wildfire Risk Reduction Project

The optimal funding opportunity available to Kore is through U.S. EPA's Climate Pollution Reduction Grant Program. There is approximately $4.75 billion in funding in this program which is a state block grant program. Governor Newsom and CARB have identified the Carbon Negative Biofuels Programs as among California's top tier priorities. The State is targeting up to $500 million from EPA to fund the program. This funding is essential given that the California Phase II funding for the program was eliminated due to California's current budget deficit.

The following is excerpted from CARB's Priority Climate Action Plan report to EPA.

[10] U.S. Department of Transportation, "Bipartisan Infrastructure Law/Infrastructure Investment and Jobs Act," at https://www.phmsa.dot.gov/legislative-mandates/bipartisan-infrastructure-law-bil-infrastructure-investment-and-jobs-act-iija

[11] U.S. Department of the Treasury, "Inflation Reduction Act, at https://home.treasury.gov/policy-issues/inflation-reduction-act#:~:text=On%20August%2016%2C%202022%2C%20President,made%20in%20the%20nation's%20history.

[12] POLITICO, "Biden's big bet hits reality," by Jessie Blaeser, Benjamin Storrow, Kelsey Tamborrino, Zack Colman and David Ferris, at https://www.politico.com/interactives/2024/biden-trillion-dollar-spending-tracker/ (emphasis in original).

Energy Measure 4: Bolster Healthy Landscapes and Resilient Communities through Expanding the Biomass to Carbon Negative Biofuels Program

This measure seeks to expand the existing Biomass to Carbon Negative Biofuels Program at the California Department of Conservation, and ultimately play a unique role in addressing climate change by producing low-carbon and carbon-negative fuels from forest and agricultural biomass while addressing critical issues such as forest health, wildfire risk, and air quality concerns. In particular, using agricultural waste that has historically been burned in the San Joaquin Valley will help reduce fine particulates across some of the State's most overburdened low-income and disadvantaged communities. The Department of Conservation would lead this measure, in partnership with various State and federal agencies, local governments, and Tribes. These entities – alongside community input to mmaximize local co-benefits – could collectively contribute to the measure's development, solicitation crafting, and application review processes.

Depending on total additional funding added to this measure, it could yield annual emissions reductions of approximately 10,000 MTCO2e, as well as roughly 38,000 MTCO2e cumulatively between 2025 and 2030, and 230,000 MTCO2e cumulatively between 2025 and 2050.

The financial scope of the program is significant, with implementation costs ranging from $60 million to $500 million per facility, where grants are designed to cover at least 10% of the total costs. CPRG funding would be leveraged and matched with private and public funding, including local funding from jurisdictions – many of which are rural – that would benefit from these facilities with enhanced forest resilience, improved air quality, and jobs.
Additionally, by avoiding wildfire risks and by providing an alternative to the open burning of agricultural waste, this measure promises substantial public health and safety benefits, for rural low-income and disadvantaged communities as well as Tribal Nations, many of which live in California's San Joaquin Valley, and face persistent air quality challenges. The program also aims to create hundreds of construction jobs and numerous long-term operational roles, with a focus on local hiring to boost employment for priority populations. This measure can yield biochar and other soil amendments that have the potential to both store carbon and improve soil quality.

The transformative potential of this program is significant. It is expected to lead to notable advancements in sustainable forestry and biofuel technology, thereby setting a national model for combining rural economic opportunities with environmental stewardship and improvements in air quality. The program also can contribute substantially to renewable energy, potentially supplying renewable electricity to the grid and replacing fossil fuel combustion.

This measure would include several major milestones. One month after CPRG funding was awarded, a solicitation would be finalized and made available for biofuels implementation. Within two months, five existing pilot regions could be awarded funds to help with biomass aggregation, and a workshop for all other interested parties would be held, in part to help ensure direct benefits to local communities. Within five months, biofuels implementation awards could be made. Within 18 months, the final legal entities in aggregation pilot regions would be established, and within two years, the first long-term feedstock contracts would be available through aggregation pilot regions. Between two and five years after the CPRG award, facilities would be built, generating carbon-negative fuels. Tracking these milestones will help ensure measure success as could the number of sites and facilities funded by the measure, biofuel

produced or energy sold, aggregation site purchases, bone-dry tons of biomass acquired, acres of improved forests, plans indicating agricultural areas targeted, lifecycle carbon assessments, awardee facility job counts, and others as appropriate.[13]

An Analysis of All Remaining Available IIRA & IIJA Has Identified Substantial Additional Federal Funding Opportunities for Kore

Due to the direct nexus between LCFS credit revenues and the economic viability of projects that low carbon fuel developers seek to finance and build, a group of low carbon fuel production companies has been funding a comprehensive analysis by Zero Emission Advisors and directed by NLC. This analysis has focused on the funding components contained in the IIJA and IRA that are most relevant to low carbon fuels and low carbon energy including funding designated for land restoration, feedstock development, wildfire risk management, energy generation, energy storage, large scale transmission, microgrids, waste and sanitation, advanced fuel technologies, hydrogen, SAF, hydrogen fuel cell and battery electric vehicles, alternative fuel and charging stations, and community assistance.

Subsequent to the identification of all of the remaining relevant funding opportunities that have a sufficient nexus with the low carbon fuel sector, the focus of the IRA/IIJA project has been to identify the highest value potential sources of funding for specific companies given that company's feedstock, fuel, technology, and its possible ancillary benefits, e.g. Kore's potential to utilize woody biomass, provide hydrogen and energy to remote rural communities, and provide new jobs and economic development to remote rural communities. **Exhibit B** provides summaries and available funds for the programs that have strong potential to either provide funding directly to Kore or to upstream wildfire risk management funding for tribes or other community partners or downstream funding for heavy-duty vehicles to transport the woody biomass. The following graphic depicts these programs and funding opportunities.

[13] CARB, "The State of California's Priority Climate Action Plan," Submitted to the U.S. Environmental Protection Agency, at https://ww2.arb.ca.gov/sites/default/files/2024-03/California%20CPRG%20Priority%20Climate%20Action%20Plan%202024%20March%201_0.pdf,

NOYES LAW CORPORATION
FUEL & CARBON LAW

IMMEDIATE FEDERAL FUNDING AVAILABLE
BIOMASS PLANT

USDA
$6.75+B

TRIBAL HAZARDOUS FUELS MANAGEMENT-
- Regional Conservation Partnership Program (RCPP) ($4.95B)($1.5B Released 4/24)(Max Award $25M Min Award $250K)(8/24 Deadline)
- Hazardous Fuels Reduction Projects in Wildland Urban Interface ($1.8B)

Max Community Fund
Hazardous Fuel Management
$6.75+B

USDA
$200M

KORE DIRECT FEEDSTOCK DEVELOPMENT FUNDS-
- Removal Of Vegetation For Biochar And Innovative Wood Products ($100M)
- Wood Innovations Grant Program ($100M)($20M Annually)($300K Per Project)

Kore
Innovative
Feedstock Processing
Plant CAPEX $3.5M

$4.75B

KORE SEED FUNDING FOR MULTIPLE LOCATIONS
- Climate Pollution Reduction Grants: Implementation Grants ($4.75B) (10% of CAPEX is CARB Estimate per Project Total) (Direct Investment)

Kore
Pyrolysis Plant
CAPEX $26M

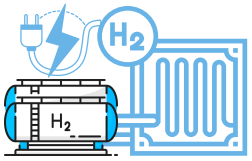
$500M

KORE DIRECT FACILITY INVESTMENT-
- Clean Hydrogen Manufacturing Recycling Research, Development, and Demonstration Program ($500M) ($100M for 2024)(Release Date TBD)

Kore
Gas Processing Plant
CAPEX $65M

$505M

Long Duration Storage and Grid Resiliency
- Energy Storage Demonstration and Pilot Grant Program ($355M) ($150M Estimate for 2024)
- Long-Duration Energy Storage Demonstration Initiative and Joint Program ($150M)



California Grid
Improvement Funds $625M

$1B

ZE VEHICLE FUNDS
- Clean Heavy-Duty Vehicles ($1B)

Max ZE Heavy Duty Funds
$1B+

NOYES LAW CORPORATION
FUEL & CARBON LAW

Conclusion

Kore appreciates the opportunity to comment on CARB's proposed amendments to the LCFS. We look forward to working with CARB to further tailor and ultimately implement amendments to the LCFS regulations.

Sincerely,

Graham Noyes
Noyes Law Corporation

Cc: Secretary Wade Crowfoot, Natural Resources Secretary
Elizabeth Betancourt, Natural and Working Lands Policy Advisor

EXHIBIT A

Carbon Negative Biomass Options – Electric Power Implications

Prepared by Stefan Unnasch, Life Cycle Associates, LLC
Date: May 8, 2024

The carbon intensity of hydrogen options plays a critical role in the development of projects in California. Numerous funding sources are available for the mitigation of GHG emissions protection of natural lands and development of low carbon fuel technologies. Several fuel pathways illustrate the role of electric power which is required for material movement, syngas compression, pumps, hydrogen compression, and liquefaction.

The pyrolysis of biomass residues to hydrogen with the co-production of biochar illustrates the opportunity. Fuel producers such as Kore have the opportunity to design systems with a wide range of process configurations. Their decisions on energy mix are driven by the carbon intensity and its effects on programs such as the Inflation Reduction Act (IRA) and LCFS.

The potential configuration of hydrogen production systems can result in a range of hydrogen production rates. Generally, the highest hydrogen production rates would be achieved with imported low CI electric power while lower hydrogen production rates could be achieved with configurations that burn more fuel gas to generated power on-site. A system that maximizes hydrogen output with input from low CI grid power would result in the largest possible emission reductions.

Biomass provides several options for carbon negative fuel pathways through the sequestration of CO_2 or production of biochar in combination with the use of low carbon biomass. The feedstocks including agricultural residues and forest residues collected to avoid wildfire risk.

The carbon intensity of many fuel options below 0 g CO_2e/MJ is possible due to the storage of carbon. In order to fully incentivize such systems, low carbon fuel programs should take into account all aspects of the carbon intensity, including the production of feedstock transport and use of processing energy, including chemicals, natural gas and electric power. Electric power for processing energy plays a role in many fuel pathways. The CI values for hydrogen systems without the effect of carbon storage are shown in Table 1.

Table 1. CI of Biomass to Fuel Pathways

Pathway	Feedstock	Refining	Grid Electricity	Transport	Fuel Combustion	Total
Petroleum Diesel	12.0	14.0	1.0	1.0	71.0	99.0
FT Diesel CCS	4.8	1.0	14.0	2.0	1.0	22.8
Plasma H2 CCS	4.7	1.0	37.5	11.0	0.0	54.2
Pyrolysis LH2, Biochar	4.7	0.0	47.5	2.0	0.0	54.2

Figure 1 shows the life cycle GHG emissions on a well to tank basis including the combustion of fuel. A MJ of biomass-based diesel displaces a MJ of diesel. However, this comparison does not take into account efficiency improvements associated with hydrogen fuels cell vehicles and the displaced diesel fuel would be roughly twice that on hydrogen on an energy basis. The key components of the carbon intensity include feedstock production, electric power for system operation and hydrogen liquefaction and compression and carbon stored either as biochar or CO_2. Carbon storage in the form of CCS or biochar could bring these fuel pathways into negative values.

Fuel developers could choose to generate power on-site; however, such a choice comes at the expense of capital cost and fuel production yield. Syngas, which otherwise could be converted to hydrogen, could power a gas turbine or steam boiler to increase on-site power. This approach minimized the use of grid power at the expense of the intended product output from the biomass energy system resulting in lower revenues and potential for incentives such as the IRA.

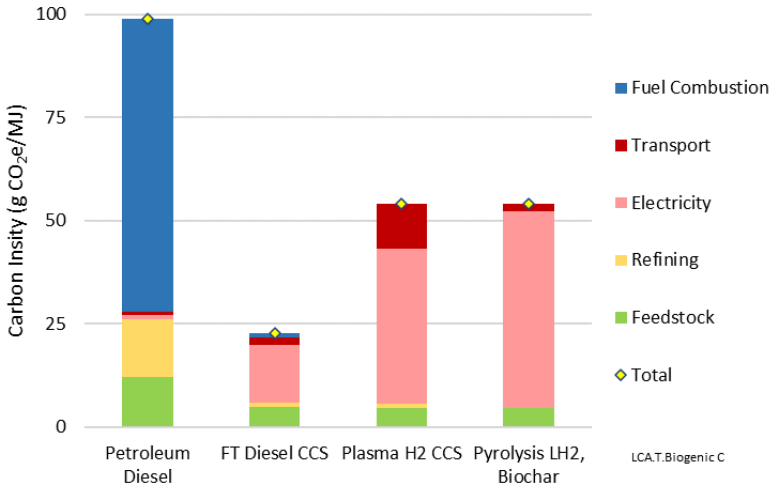


Figure 1. Typical carbon intensity of biomass to fuel pathways (excluding carbon storage).

The IRA guidance takes into account the marginality of renewable power for not only hydrogen production by electrolysis but all fuel production systems. As such, producing low CI hydrogen with renewable power requires achieving the “three pillars” of renewability such that the source of power is new, time coincident, and generated within the region where the power is consumed. These IRA requirements apply not only to hydrogen production for electrolysis but for all process energy inputs to make hydrogen. The IRA requirement is considered to be stringent and alignment with the California program would be appropriate.

The use of zero carbon process power is illustrated in Figure 2. The reduction in GHG emissions from grid average power eliminates emissions associated with processing equipment, hydrogen compression, CO_2 capture and liquefaction, and hydrogen liquefaction. Essentially most of the positive GHG emissions are eliminated allowing for the CO_2 removal benefits of biomass strategies to be utilized to their full effect.

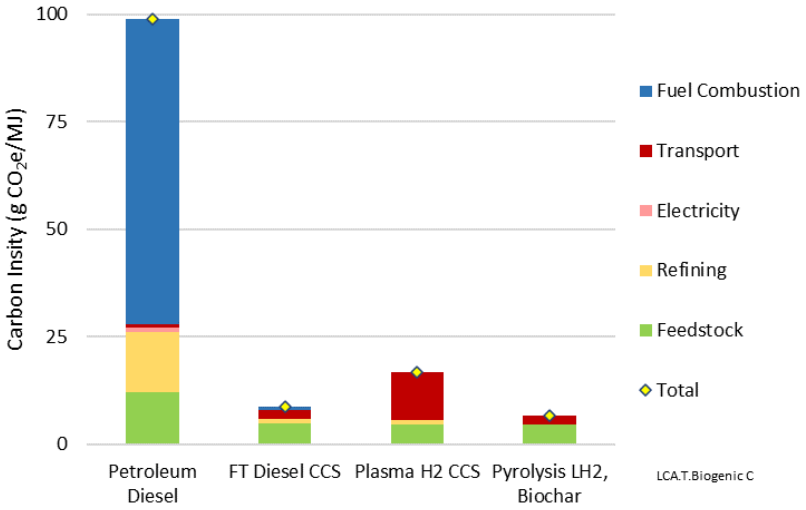


Figure 2. Biomass fuel pathways with renewable process power (excluding carbon storage).

Table 2 illustrates the potential GHG reduction potential when carbon removals such as CCS[1] and biochar[2, 3] storage are included. Both of these strategies are cited as key options for achieving California's climate goals. CCS sequesters CO_2 for permanent storage while biochar allows for the storage of inactive carbon in soils. CO2 which is captured from gasification processes is also a potential feedstock for e-fuels which use low CI power to create hydrogen which is reacted to produce syngas for methanol or Fischer Tropsch fuel production.

[1] https://ww2.arb.ca.gov/resources/documents/carbon-capture-and-sequestration-protocol-under-low-carbon-fuel-standard
[2] https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Expanding-Nature-Based-Solutions/CNRA-Report-2022---Final_Accessible.pdf
[3] https://bof.fire.ca.gov/media/oobbtosm/thengane_2021_ca_biochar_market-002-_ada.pdf

Table 1. CI of Biomass to Fuel Pathways

Pathway	CI (g CO_2e/MJ Fuel)		
	Grid Electricity	Wind/Solar	Wind/Solar and Storage
Petroleum Diesel	99	98	0
FT Diesel CCS	22.8	8.8	-165.6
Plasma H2 CCS	54.1	16.7	-180.6
Pyrolysis LH2, Biochar	54.2	6.7	-172.0

Figure 3 shows the net CI when carbon storage is included in the pathway. The use of low CI power enables maximum fuel production. Furthermore, grid electricity does not detract from the carbon removals achieved with these pathways.

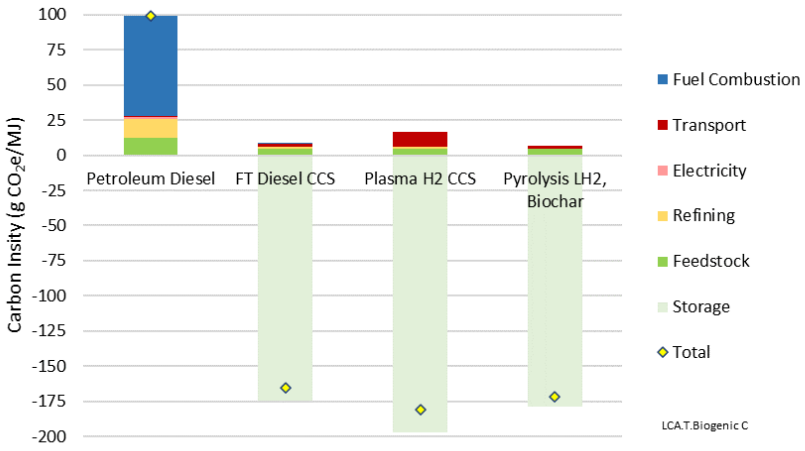


Figure 3. Biomass fuel pathways with renewable process power and biochar.

Other Potential Federal Funding Sources for Kore And Kore-related Projects

Agency	Program	Program Description	Funding Amount
Department of Agriculture	Wood Innovations Grant Program	To provide grants under the wood innovation grant program in section 8643 of the 2018 Farm bill, including for the construction of new facilities that advance the purposes of the program and for the cost of transporting of biomass from hazardous fuels reduction projects to facilities for processing.	**$100,000,000**
Department of Agriculture	Hazardous Fuels Reduction Projects in Wildland Urban Interface	To complete hazardous fuels reduction projects on National Forest System land within the Wildland Urban Interface.	**$1,800,000,000**
Department of Agriculture	Regional Conservation Partnership Program (RCPP)	To support the Regional Conservation Partnership Program (RCPP), a partner-driven approach to conservation that funds solutions to natural resource challenges on agricultural land by leveraging collective resources and collaborating to implement natural resource conservation activities.	**$4,950,000,000**

Agency	Program	Program Description	Funding Amount
Department of Agriculture	Removal Of Vegetation For Biochar And Innovative Wood Products	This program, through contracting or employing crews of laborers, supports the modification and removal of flammable vegetation on Federal land and for using materials from treatments, to the extent practicable, to produce biochar and other innovative products, including through the use of locally based organizations that engage young adults, Native youth, and veterans in service projects, such as youth and conservation corps.	**$100,000,000**
Department of Energy	Long-Duration Energy Storage Demonstration Initiative and Joint Program	To establish a demonstration initiative composed of demonstration projects focused on the development of long-duration energy storage technologies.	**$150,000,000**
Department of Energy	Energy Storage Demonstration and Pilot Grant Program	To enter into agreements to carry out 3 energy storage system demonstration projects.	**$355,000,000**
Department of Energy	Clean Hydrogen Manufacturing Recycling Research, Development, and Demonstration Program	To provide Federal financial assistance to advance new clean hydrogen production, processing, delivery, storage, and use equipment manufacturing technologies and techniques.	**$500,000,000**
Environmental Protection Agency	Clean Heavy-Duty Vehicles	To provide funding to offset the costs of replacing heavy-duty Class 6 and 7 commercial vehicles with zero-emission vehicles; deploying infrastructure needed to charge, fuel, or maintain these zero-emission vehicles; and developing and training the necessary workforce.	**$1,000,000,000**

Agency	Program	Program Description	Funding Amount
Environmental Protection Agency	Climate Pollution Reduction Grants: Implementation Grants	To provide grants to Tribes, states, air pollution control agencies, and local governments to develop and implement plans for reducing greenhouse gas emissions. The statute allocates $250 million for planning grants and $4.750 billion for implementation grants.	**$4,750,000,000**