UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

ARCHES H2 Alliance for Renewable Clean Hydrogen Energy Systems

POLICY BRIEF: California's Biomass Potential for Hydrogen Production

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Executive Summary

Low-carbon and carbon-negative fuels, such as hydrogen produced from agricultural residues, woody biomass, and municipal solid waste (MSW) can help California achieve its greenhouse gas (GHG) reduction targets. Hydrogen production through biomass gasification is a mature technology. Biomass resources are promising in California, especially in the near term. California could meet 95% of its 2050 hydrogen demand by utilizing waste biomass. With California's fast-growing hydrogen market and abundant agricultural waste, forest biomass, and MSW, the state has the potential to lead in the clean hydrogen industry.

This policy brief outlines the potential of biomass utilization in hydrogen production and provides status and future potential in California. It aims to inform policy makers in areas such as research and innovation funding and the provision of physical infrastructure.

Description of the Problem

California produces 12% of all agricultural goods in the U.S., bringing in over $50 billion each year. This strong agricultural sector creates a lot of waste, such as crop leftovers, animal manure, and by-products from food processing. This waste, along with forest biomass and MSW, has great potential for producing renewable energy, improving soil, and creating other valuable products. One way to use this waste is to produce hydrogen through a process called gasification.

Table 1: Announced Biomass Hydrogen Facilities

Company	Location	Commission Date
Yosemite Clean Energy	Butte	2024
	Tuolumne	2025
	Tulare	2026
Mote Hydrogen	Bakersfield	2024
	Sacramento	2027
H-Cycle	Los Angeles	2026
	Butte	2026
	Bakersfield	2026
	Contra Costa	2024
Kore	Los Angeles	2021
	Bakersfield	2023

California produces over 70 million tons of dry waste biomass every year. By 2050, this amount could increase by 16% (Breunig 2018). Utilizing waste biomass, California could produce about 3.8 million tons of hydrogen annually through gasification, meeting around 95% of State's hydrogen demand by 2050 (Baker et al. 2019). While making hydrogen this way is possible, it needs supportive policies, infrastructure development and a steady supply biomass supply. Incorporating existing facilities into the hydrogen infrastructure network could capitalize on their position as an aggregator of biomass and serve to improve overall efficiency of resource use.

Current Status

Despite existing policy support, biomass-based hydrogen has not yet reached commercial-scale production in the California. Several facilities are planned for CA that will utilize agricultural waste or sustainably sourced forest biomass to produce renewable hydrogen and/or other renewable fuels (Table 1). The cost of producing hydrogen from biomass is estimated to be $2.24/KG (see Figure 1). This suggests that hydrogen from biomass could compete with the current option of making hydrogen from natural gas at refueling stations in California. However, whether biomass hydrogen will be competitive depends on how well the entire supply chain is designed and managed. Installation of 200 new hydrogen refueling stations in the state will be needed by 2030.

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Future Applications

1. Heavy Equipment

Hydrogen is increasingly being used to power heavy equipment in agriculture. Examples include:

- **Hydrogen-Powered Tractors**: Companies like New Holland are developing tractors that run on hydrogen, reducing emissions and reliance on diesel.

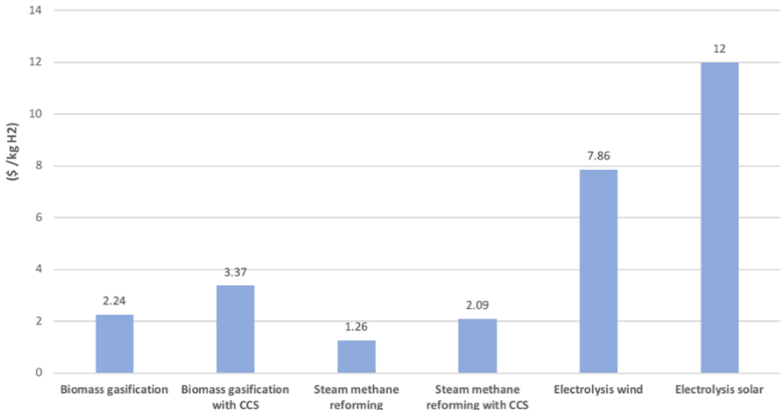

Figure 1: Hydrogen Production Costs (Parkinson et al. 2019)

- **Fuel Cell Forklifts**: Widely used in warehouses and distribution centers, these forklifts offer a clean and efficient alternative to battery-powered models.

2. Green Ammonia

Hydrogen plays a crucial role in the production of ammonia, a key ingredient in fertilizers. Traditional ammonia production relies on natural gas but using hydrogen from renewable sources can significantly reduce the carbon footprint of fertilizers. Companies such as CF Industries are investing in green ammonia projects that use hydrogen produced from renewable sources, including agricultural waste. By 2050, the two largest markets for ammonia are likely to be fertilizer and maritime shipping fuel.

Larger production plant capacities will be needed to reach economic feasibility at current ammonia market price. Lower production costs or higher costs for fossil-based alternatives would be required to make biomass-based ammonia production economically viable. Although there are no commercial-scale green ammonia projects in California yet, several commercial-scale projects are under development in Texas. ARCHES' efforts to create a renewable clean hydrogen economy, along with the pilot green ammonia projects in the City of Lancaster, boost California's potential to join the race for green ammonia development and promote local economic and job growth.

Policy Recommendations

- Provide technical and financial support to companies interested in developing biomass supply chains to expand clean hydrogen markets.
- Support policies that promote the hydrogen derivatives sector (ammonia), including encouragement of investment mechanisms, prioritization of key infrastructure, and creation of markets.
- Invest in regional centralized facilities that are close to feedstock (forest and ag) sites for storage and pretreatment purposes.
- Promote investments in research and deployments, technological advancements, and supportive policies which will advance the usage of hydrogen derivatives for improved storage, transport and distribution in existing and emergent infrastructure and technologies.
- Enhance government support through incentives such as procurement preferences, mandates on public agency purchases, and expediting the permitting process for businesses targeting priority sectors such as rural regions with abundant biomass resources, circular bioeconomy projects, MSW utilization, etc.