GREEN HYDROGEN COALITION

GREEN HYDROGEN

A Key Resource for California's Clean Energy Transition

WHAT IS GREEN HYDROGEN?

Green hydrogen (GH_2) is a **carbon-free, renewable resource that can replace fossil fuels** in some of the heaviest polluting and hardest-to-electrify economic sectors, including:

Industrial Processes | Ships | Airplanes | Heavy Duty Trucks | Material Handling Equipment | Locomotives

Many countries (e.g., Japan, Canada, Germany) have studied the potential pathways to end their dependence on fossil fuels and arrived at the same conclusion: GH_2 plays a fundamental role in accelerating their transition to a clean energy economy.

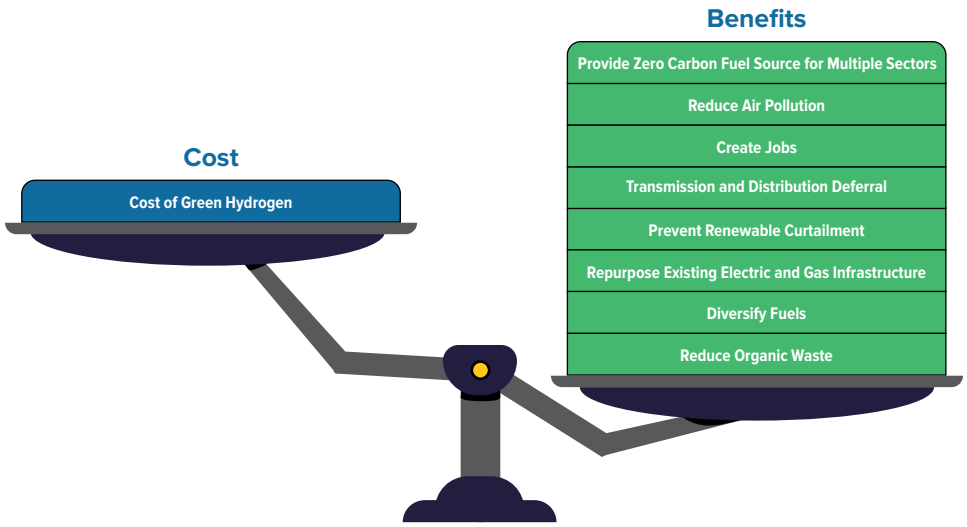
The Green Hydrogen Coalition (GHC) defines "green hydrogen" as hydrogen that is produced from non-fossil fuel feedstocks and has climate integrity. The GHC supports a well-to-gate carbon intensity framework consistent with the U.S. Department of Energy.

Hydrogen has been safely used in semiconductor manufacturing, fertilizer production, oil refining, and other industrial processes for decades, with over 94 million tonnes consumed each year around the world.[1] Historically, hydrogen for industrial uses has been produced from fossil fuels.[2] Today, GH_2 can be made from renewable resources like wind, solar, and biomass, and many studies have shown that when produced, transported, and stored at scale, GH_2 can be cost competitive with fossil fuels.[3]

UNDERSTANDING THE BENEFITS OF A GREEN HYDROGEN ECONOMY

Many benefits can be realized from the development of a GH_2 economy at scale in California. In this document, the GHC will highlight 5 key benefits: air quality improvements, a clean and reliable power sector, job creation, organic waste reduction, and economic growth potential.

The Benefits of GH_2



1 | Green hydrogen can replace fossil fuels in hard-to-electrify mobility applications, leading to significant air quality and public health improvements.

More than 75% of California's nitrogen oxide (NOx) emissions, a pollutant that can cause respiratory illnesses, originates from combustion of fossil fuels in mobility applications[4] (i.e., vehicles, offroad equipment, ships, and airplanes). GH_2 and its derivatives can be utilized as a renewable alternative to displace fossil fuels in these sectors, which are hard to directly electrify because of their duty cycles, routes, and/or weight.

Since the only emission from GH_2 usage in fuel cells is water vapor and warm air,[5] the adoption of hydrogen fuel cell equipment in place of diesel or gasoline combustion in mobility sectors will greatly reduce NOx and other harmful pollutants.

Learn more about the pollution reduction benefits of green hydrogen adoption. Check out the GHC's HyBuild LA Report, which features a UC Irvine study on the atmospheric impacts within the South Coast Air Basin of replacing fossil fuel combustion technology with hydrogen fuel cells.

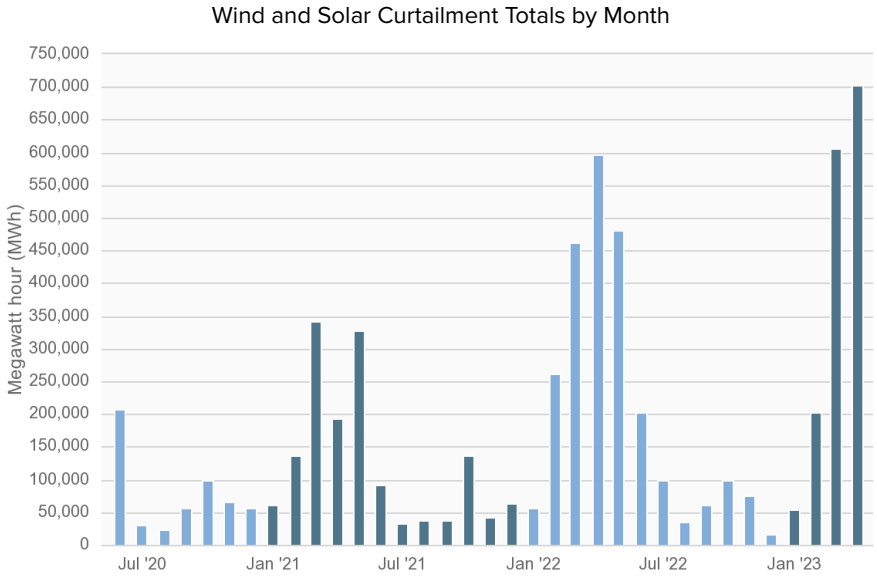
2 | Green hydrogen can be a source of long-duration energy storage, enabling California to achieve its 100% renewable electricity goal while maintaining grid resiliency.

Today, wind and solar are the cheapest sources of renewable electricity and should be widely deployed to help California attain its decarbonization targets. However, studies have shown that California also needs resources that power the grid when the sun is not shining, and the wind is not blowing. Today, this need for on-demand power is primarily met by burning fossil fuels, such as natural gas.

As the portfolio of renewable energy continues to grow, it is essential to balance its output and variability, as some months and seasons will have excess renewable energy, whereas others will fall short to meet energy needs. Today, excess renewable energy production is not utilized. Production of GH_2 creates the opportunity to capture wind and solar and store it for weeks, months, and even seasons to be used when needed.

By utilizing GH_2 as a zero-carbon, on-demand power source, California's electric sector can end its dependence on natural gas. Further, this can be done affordably by reusing existing power sector infrastructure. Without utilizing this clean, reliable resource, California will continue to be dependent on fossil fuels.

Excess Renewable Energy That is Not Utilized Increases Each Year

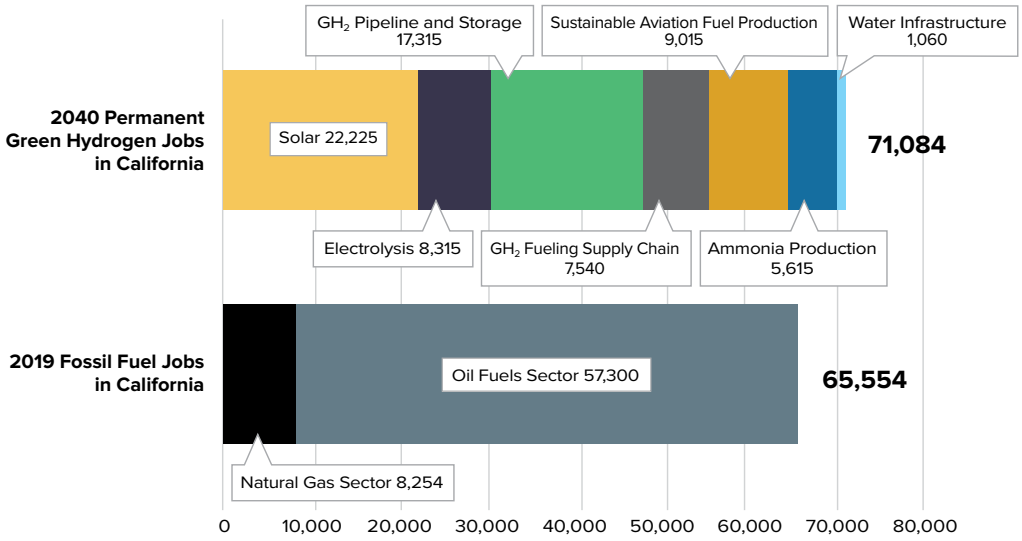


Source: California ISO, Managing Oversupply. www.caiso.com/informed/Pages/ManagingOversupply.aspx#dailyCurtailment

3 | Establishing a green hydrogen economy in California will create tens of thousands of family-sustaining jobs.

A study from UC Irvine estimates that approximately 71,000 full-time, permanent jobs will be created to service California's GH_2 demand,[6] outnumbering the current quantity of fossil fuel jobs in the state. Many of these jobs are similar to incumbent fossil fuel industry jobs (e.g., pipeline system management). These diversely-skilled roles provide strong opportunities for fossil fuel workers to transition and participate in the clean energy future.

Permanent Job Creation to Serve California's GH_2 Demand



Fossil Fuel Jobs Source: California Energy and Employment Report (CAEER), 2020. www.energy.ca.gov/filebrowser/download/2272
Green Hydrogen Jobs Source: Adapted from UC Irvine Advanced Power and Energy Program for HyBuild LA, 2022. A multiplier is applied to LA green hydrogen job estimates to scale to statewide levels. www.ghcoalition.org/ghc-news/hybuild-la-phase-2-report.

"Adding hydrogen to our state's energy portfolio is not only an important step in decarbonizing the state, but will also foster green careers for thousands throughout California."
— Lorena Gonzalez, Executive Secretary-Treasurer of the California Labor Federation

4 | California law requires the state to divert 75% of its organic waste away from landfills by 2025[7] – but where will it go? Producing green hydrogen from organic waste can reduce short-lived climate pollutants and help to solve California's waste problem.

More than one-third of California's waste can be classified as organic waste (e.g., food waste, agricultural waste, and forest biomass).[8] Forest management, which is needed to protect California from catastrophic wildfires, also yields organic biomass waste.

Cofiring, burning, or leaving organic waste to decay is a large source of two of the most powerful short-lived climate pollutants: methane[9] and black carbon.[10] While these pollutants have shorter lifetimes[11,12] than that of CO_2,[13] they can have more severe impacts in the atmosphere: methane is "more than 25 times as potent as carbon dioxide at trapping heat in the atmosphere,"[14] while black carbon has a "warming impact on climate [that is] 460-1,500 times stronger than CO_2 per unit of mass."[15]

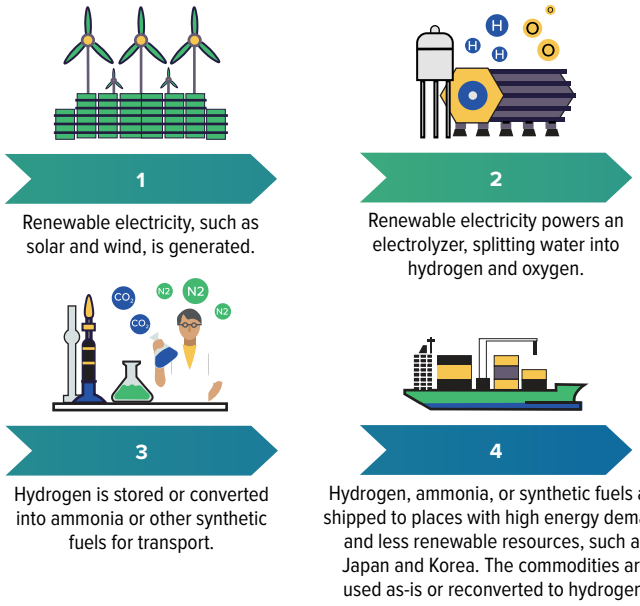
Organic waste can instead be utilized to produce carbon-negative GH_2,[16] while also reducing landfill waste, preventing forest fires, and helping California to meet its climate goals. In addition, waste-to-hydrogen projects bring important clean energy job opportunities to rural communities – where much of this abundant organic waste is located.

5 | Green hydrogen can position California to be a powerhouse in the global clean energy market.

GH_2 and its derivatives can support the decarbonization of maritime shipping and aviation sectors. As home to the largest ports in the U.S. (Port of LA and Long Beach) and one of the country's busiest airports (LAX), California can further demonstrate its climate leadership by establishing some of the world's busiest clean transit routes.

But California can have an even greater global reach. Countries like Japan, who do not have as robust renewable energy resources,[17] are planning to import GH_2 to help meet their decarbonization goals. California can leverage its strong solar and offshore wind potential and its abundant organic waste resources to export low-cost GH_2 at-scale, creating economic opportunities for the state while also advancing the global clean energy transition.

California Can Export GH_2 to Fuel the Global Energy Transition



Resources:

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LEARN MORE ABOUT THE GREEN HYDROGEN COALITION & ACCESS FREE RESOURCES:

THE WORK OF THE GHC IS DRIVEN BY ITS CORE VALUES:

- Impact
- Respect & Collaboration
- Environmental Justice
- Integrity
- Safety
- Technology & Business Model Neutral

GREEN HYDROGEN COALITION

Founded in 2019, the Green Hydrogen Coalition (GHC) is a 501(c)(3) educational nonprofit that is focused on the role of green hydrogen to accelerate a clean and just energy transition. As California works towards carbon neutrality by 2045, GH_2 will be a critical tool to achieve economy-wide decarbonization alongside other clean energy technologies. The GHC works to advance education, policies, and practices to achieve progress for GH_2. For more information, visit **ghcoalition.org**