California Hydrogen Business Council

Hydrogen Means Business in California!

California Hydrogen Coalition

September 22, 2023

**Re: IEPR and SB 1075 Workshops**

On behalf of the California Hydrogen Business Council and California Hydrogen Coalition we thank the California Air Resources Board (CARB) California Public Utilities Commission, and California Energy Commission (CEC) for the time and effort taken to develop the materials and panels for the September kickoff workshops for Senate Bill 1075 (Skinner, Chapter 362, Statutes 2022) and the Integrated Energy Policy Report (IEPR). We look forward to the multi-agency collaboration that is necessary to achieve the objectives and implementing those recommendations set forth in the Scoping Plan and SB 1075 to help California achieve carbon neutrality.

We request alignment of the IEPR, Scoping Plan, implementation of SB 1075, and the hydrogen market development strategy, along with federal policy to maximize the benefits of using hydrogen for decarbonization and air quality. As Commissioner Gunda stated during the workshop, future workforce development will be driven by the alignment of these policies and the ability to leverage the available federal funding to achieve California's ambitious climate objectives. The federal government just launched a hydrogen interagency task force[1] to take a whole of government approach to executing the national clean hydrogen strategy,[2] including development of a robust market supported by domestic supply chains and sustainable jobs, and California can align with this approach.

**Building on the 2022 Scoping Plan**

The 2022 Scoping Plan is the first to look toward a carbon-neutral future and examines the various technological pathways needed to achieve this monumental goal by 2045. Hydrogen's role is significant and will provide meaningful emissions reductions throughout every segment of the economy. We believe in the strong vision for hydrogen that enhances the efficacy of emission reductions while also meeting the original intent of AB 32 (Núñez, Chapter 488, Statutes 2006) of cost-effective and technologically feasible planning. Supporting the development of a robust hydrogen economy will also protect our highly skilled and trained workforce without disruptions in employment.

SB 1075 and the IEPR should build on this strong foundation and integrate the Scoping Plan modeling into the data and analysis. The Scoping Plan looks across a significant portion of California's economy where emissions must be mitigated and clearly indicates that all sectors require a transition to new energy resources. Due to the difficulty and enormity of this task, we understand and appreciate the complexity of accurately modeling the risks and rewards across a dynamic and competitive energy economy.

Utilization of a wide variety of hydrogen production pathways and end uses will help to maximize emissions reductions, cost-effectiveness, and lead to a carbon-neutral future that is resilient, reliable, and self-sustaining. To achieve California's goals, we must revolutionize our energy systems while improving the lives and livelihoods of all Californians. Transitioning to an energy system and economy

[1] https://www.hydrogen.energy.gov/interagency.html

[2] https://www.hydrogen.energy.gov/clean-hydrogen-strategy-roadmap.html

supported by hydrogen will enhance the future of California while achieving climate and air quality goals.

Additionally, we suggest building on other efforts to help inform and unify this work with other proceedings and regulatory requirements by incorporating the CEC funded "Roadmap for the Deployment of Renewable Hydrogen Production Plants in California," California State Transportation Agency's SB 671 (Gonzalez, Chapter 769, Statutes 2021), and the sector specific white papers developed by Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) to enable California's hydrogen hub application as well as supporting the needs in the transportation and energy sectors with a thorough examination of how hydrogen will play a role in achieving our Renewable Portfolio Standard mandate, Advanced Clean Trucks, Innovative Clean Transit, Advanced Clean Cars II, and Advanced Clean Fleets regulations. Additionally, Governor Newsom has directed the Governor's Office of Business and Economic Development (GO-Biz) to develop California's Hydrogen Market Development Strategy which will incorporate the SB 1075 report. By utilizing the existing base of research and regulatory development to achieve the objectives of SB 1075, our hope is that these proceedings will reinforce and set a clear pathway for enabling policies to unlock the benefits of fully integrating hydrogen into California's decarbonized and renewable economy. *We believe a well-planned – "no regret" – vision for hydrogen in California will enable even greater emission reductions thanks to cost-effective scaling, strong economic performance, and consumer demand.*

**Carbon Intensity Focus**

In the Scoping Plan, CARB acknowledges that "green hydrogen" extends beyond electrolytic hydrogen produced from renewables.[3] Consequently, the Scoping Plan refrains from providing a definitive definition of hydrogen but rather outlines the types of hydrogen eligible within its scope. Our concern arises from the fact that eligibility criteria across multiple statutes, regulations, and plans established by various regulatory bodies in California lack clarity and consistency. This situation poses uncertainties for investments aimed at decarbonizing hydrogen.

The absence of uniform statewide definitions or standards may hinder the growth of the hydrogen market in California. Furthermore, it could impede the state's ability to collaborate with neighboring states interconnected to California's electric grid and natural gas system in pursuit of decarbonization goals. To address these concerns, we strongly recommend that CARB consider establishing hydrogen eligibility based on a carbon intensity (CI) framework, utilizing a well-to-gate life cycle assessment (well-to-gate LCA).[4]

Adopting a CI framework through a well-to-gate LCA approach is technology-agnostic, focusing solely on lifecycle emissions stemming from onsite and upstream production. This approach fosters healthy competition, permitting any hydrogen source to thrive if it meets the desired lifecycle emissions threshold. Moreover, it recognizes the potential emergence of new hydrogen production technologies, such as artificial photosynthesis, which may complement or surpass existing methods.

[3] See scoping plan p. i.

[4] We define a well-to-gate life cycle emissions boundary to include the scope set forth by the IPHE in its recent white paper. Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen, IPHE Hydrogen Production Analysis Task Force, https://www.iphe.net/_files/ugd/45185a_ef588ba32fc54e0eb57b0b7444cfa5f9.pdf

The concept of defining eligible hydrogen based on a CI framework is gaining traction globally, with examples including British Columbia,[5] the European Union,[6] and the United States. For instance, the recent United States Infrastructure Investment and Jobs Act (Infrastructure Bill) defines "clean hydrogen" as hydrogen with a CI equal to or less than 4 kilograms of CO2e per kilogram of hydrogen.[7] This legislation directs the Department of Energy (DOE) in consultation with the Environmental Protection Agency (EPA) to develop an initial standard for the CI of clean hydrogen production, establishing a rigorous framework for evaluating production pathways and robust measurement, verification, and reporting structures.

Another example of a CI framework is CARB's Low-Carbon Fuel Standard (LCFS), which sets an annual CI standard to reduce the CI of transportation fuel in California by at least 20 percent by 2030. The LCFS allows the market to determine the hydrogen mix needed to meet program targets, not precluding any production pathways or feedstocks if they fall within the specified carbon threshold. The LCFS has proven effective in reducing greenhouse gas emissions, diversifying California's fuel pool, and enhancing air quality.

CARB has a unique opportunity to follow a similar approach by adopting its own CI framework, specifically tailored for hydrogen within the context of this Scoping Plan. CARB can draw from the experiences of examples mentioned earlier to develop a CI framework aligned with California's unique needs. Such a framework would explicitly exclude the use of fossil resources and encourage technological innovation, provided that the innovations maintain climate integrity by emitting minimal greenhouse gases in a well-to-gate LCA. Fostering innovation will naturally increase competition and attract greater private hydrogen investment, ultimately benefiting California ratepayers.

In support of SB 1075, we endorse the development of a hydrogen CI framework based on a well-to-gate LCA, extending the definition of hydrogen eligibility beyond transportation fuels and ARCHES, thereby advancing the state's decarbonization efforts. This would create an objective standard on which hydrogen could be measured across agencies and programs.

With respect to the policy and the regulatory approach for hydrogen production or incentives, we would like to emphasize:

Additionality, time matching, and overly narrow deliverability standards should not be required for jurisdictions like California with a Renewable Portfolio Standard (RPS) and a binding greenhouse gas emissions limit.

- Requirements for new and incremental renewables assumes that the grid utilization is perfectly efficient and effective. Furthermore, additionality will subject hydrogen projects to multi-year interconnection delays, while achieving no emissions benefits for the grid or end uses necessary to meet the State’s energy and climate change goals. California law already protects against resource shuffling with explicit prohibitions in Public Utilities Code Section 454.53.

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[5] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternativeenergy/electricity/bc-hydro-review/bc_hydrogen_strategy_final.pdf
[6] https://www.insideenergyandenvironment.com/2021/04/the-european-commission-approves-the-eucriteria-on-sustainable-hydrogen-activities/
[7] United States' Bipartisan Infrastructure Law (BIL), Section 40315

- Like California's load serving entities in the RPS, hydrogen should be allowed to use annual time matching. Numerous studies[8][9] indicate that annual matching drives operational efficiency and more desirable grid outcomes.
- Requiring the renewable power generation resource to match the location of the hydrogen production asset will add additional costs to many projects and inhibit placing renewable energy generation and hydrogen production in the best locations.
- As with the RPS, biomass and biogenic resources should be eligible hydrogen sources within California and included within the IEPR.

Hydrogen must have parity with other clean energy resources. We should avoid applying standards to hydrogen production and use that the grid and direct electrification end uses are not required to or able to meet. These concepts risk the beneficial outcomes of hydrogen projects and jeopardize meeting decarbonization targets, job creation, and energy security.

| Lifecycle GHG Intensity (GREET Well to Gate) | Lifecycle in CA LCFS gCO2e/MJ (using LHV for H2) | PTC $Value per kg (% of max credit) | ITC % Value (% of max credit) |
|---|---|---|---|
| < 0.45 kg | < 3.75 gCO2e/MJ | $3.00 (100%) | 30% (100%) |
| < 1.5 and ≥ 0.45 kg | < 12.5 gCO2e/MJ and ≥ 3.75 gCO2e/MJ | $1.00 (33.4%) | 10.2% (34%) |
| < 2.5 and ≥ 1.5 kg | < 20.84 gCO2e/MJ and ≥ 12.5 gCO2e/MJ | $0.75 (25%) | 7.5% (25%) |
| ≤4 and ≥ 2.5 kg | ≤33.34 gCO2e/MJ and ≥ 20.84 gCO2e/MJ | $0.60 (20%) | 6% (20%) |

*Table 1 - CI Conversion from Federal Policy to California Policy – for reference the average grid carbon intensity in California is 81 gCO2e/MJ[10]*

**A Virtuous Cycle**

Hydrogen, the universe's most abundant element, holds promise as a clean energy carrier, aligning with sustainability goals. Harnessing hydrogen (H2) as an energy carrier is the next step in the energy evolution, leading to a cleaner, healthier, and more sustainable environment. Hydrogen production, storage, and end-uses offer benefits like our fossil-based energy system, such as productivity, reliability, resiliency, and economic advantages, but without negative environmental consequences. These findings are endorsed by the Intergovernmental Panel on Climate Change (IPCC), a United Nations advisory body.

For decades, Californians sought to "close the loop" on waste, including organic waste and curtailed renewable energy. Hydrogen emerges as the answer to some of the state's greatest clean energy and transportation challenges. The mantra "reduce, reuse, and recycle" aptly applies to the burgeoning hydrogen economy.

[8] https://www.plugpower.com/the-road-to-clean-hydrogen-getting-the-rules-right-report-emphasizes-impacts-to-climate-goals-under-consideration-for-the-hydrogen-ptc/

[9] https://acore.org/new-analysis-finds-annual-matching-requirement-for-hydrogen-production-will-not-raise-emissions-and-will-avoid-cost-barriers/

[10] https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/comments/tier2/2023_elec_update.pdf

To underpin the economics of renewable electricity through the full utilization of wind and solar assets, sustainable water electrolysis for hydrogen production is crucial. Electrolysis will play a predominant role in hydrogen generation, often coupled with dedicated "behind-the-meter" renewable electricity generation. Beyond fuel production, managing electrolyzer loads can support the grid during peak demand. Renewable and clean hydrogen will be used in turbines and fuel cells to provide firm and peaking power to the grid. Excess hydrogen will be stored in geologic formations and compression tanks, available for dispatch when needed, offering months of energy reserves without requiring major lifestyle changes to meet climate goals.

Upcycling biomethane, biomass, and non-recycled municipal waste feedstocks into hydrogen presents a tremendous opportunity to meet mandated emissions reductions, including those required by SB 1383 and the Short-Lived Climate Pollutant Reduction Strategy. Hydrogen mitigates emissions by utilizing waste sources like landfills, Publicly Owned Treatment Works (POTWs), and biomass disposal, including agricultural waste and wildfire mitigation byproducts, to produce low-to-negative carbon hydrogen, all while avoiding undue costs to ratepayers.

Steam methane reformation of biogas/biomethane offers a high-efficiency, low-carbon pathway for mitigating methane emissions from sources like landfills, dairies, and POTWs, promoting anaerobic digestion capacity to meet organic waste diversion goals and climate pollutant reduction targets. Newer hydrogen production technologies like steam/CO2 reforming and municipal solid waste utilization also produce negative carbon hydrogen for energy and transportation. Repurposing steam methane reformation facilities with renewable feedstock is a cost-effective step towards decarbonizing hydrogen production and fuel cell adoption, creating a virtuous cycle.

Thermochemical biomass-to-hydrogen conversion manages waste from forestry and agriculture while offering economic benefits and lowering emissions, replacing open combustion-based practices. Lawrence Livermore National Laboratory's "Getting to Neutral" study highlights biomass gasification's potential for CO2 removal at low cost[11], aligning with renewable hydrogen goals.

Each of these clean hydrogen production pathways is essential for achieving carbon neutrality, delivering co-benefits, maximizing renewable energy projects, and minimizing short-lived climate pollutant emissions. Creating a high-value energy carrier for various sectors, including transportation, industry, agriculture, and electricity, mitigates investment risks, leading to better economic outcomes.

In California's transition to carbon neutrality, leveraging the existing infrastructure from the oil, gas, and utility sector for renewable and clean hydrogen distribution is key. Starting with blending standards to reduce natural gas carbon content and the conversion of some pipelines to hydrogen in industrial clusters, California can transition energy use while maintaining the existing workforce. Repurposing infrastructure also preserves ratepayer investments in the pipeline network, allowing rapid hydrogen scaling and sector-to-sector transitions, avoiding environmental and economic impacts from leakage without viable solutions for every sector.

[11] https://gs.llnl.gov/sites/gs/files/2021-08/getting_to_neutral.pdf, page 5

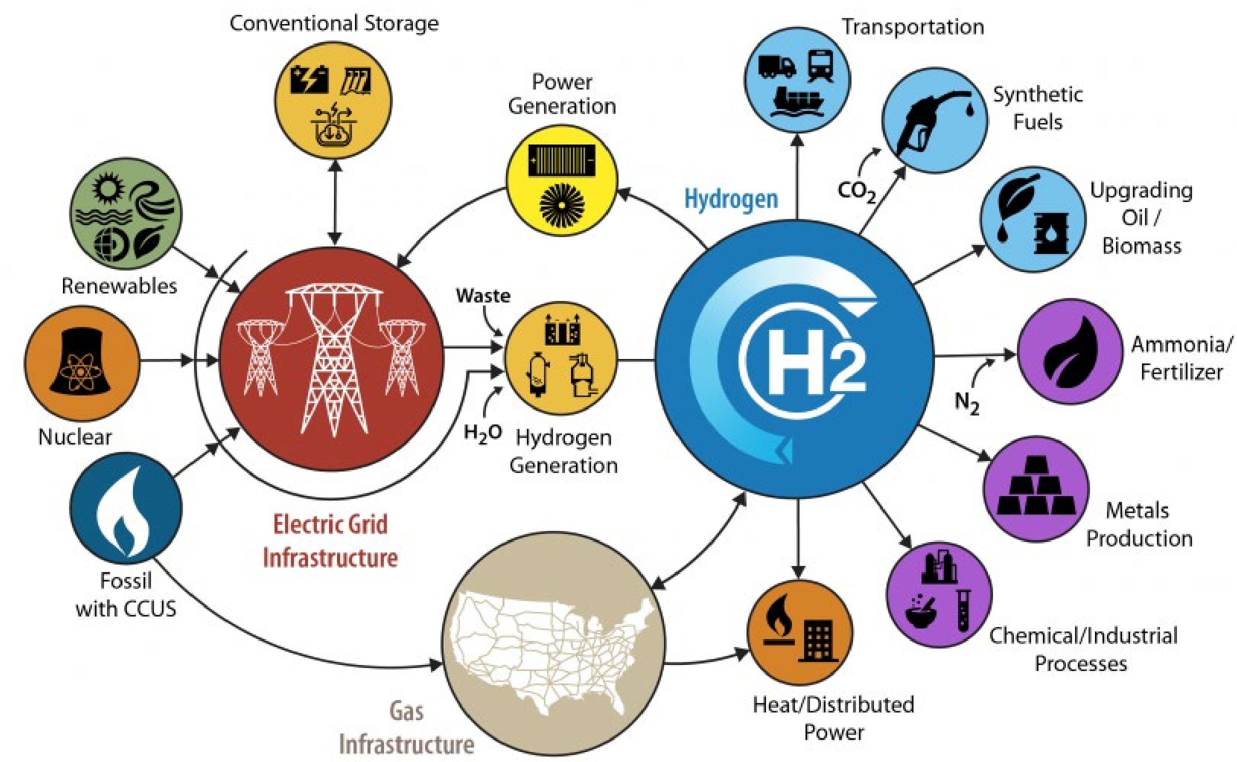


*Figure 1 https://www.energy.gov/eere/fuelcells/h2scale*
*This is an illustration from The Department of Energy depicting sector-to-sector synergies in a hydrogen economy, but it is important to note this is not comprehensive of all the emerging production pathways or end uses, and some pathways will not be applicable to California.*

**Transportation Sector**

The 2020 Mobile Source Strategy foresees a substantial adoption of fuel cell electric vehicles (FCEVs) in the transportation sector, projecting that they could account for over 22.5% of total vehicle sales by 2035, with approximately 1,229,450 light-duty FCEVs expected to be on the road by that year.[12] Furthermore, the Advanced Cars II regulation, aligned with Governor Newsom's Executive Order N-79-20, anticipates that 17% of medium- and light-duty zero-emission vehicles (ZEVs) will be FCEVs by 2035.[13] This projection considers various factors, including the evolving needs of super-commuters, construction workers, and those in the agricultural sector, as well as the expanding presence of transportation networking companies.

It is noteworthy that the demand for fuel cell vehicles is poised to surge rapidly once a comprehensive infrastructure is in place to enable statewide refueling as we have seen other jurisdictions bypass California in ambition, station numbers, and vehicles sales with Korea having almost twice (over 29,000 and growing) as many FCEVs on the road as California.[14][15]

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[12] https://ww2.arb.ca.gov/sites/default/files/2020-11/LDV_MSS_supporting_materials_ISAS_Nov2020.xlsx
[13] https://ww2.arb.ca.gov/events/public-workshop-advanced-clean-cars-ii-1 , Slide 62
[14] https://www.ieafuelcell.com/fileadmin/publications/2023/2023
[15] https://h2fcp.org/sites/default/files/FCEV-Sales-Tracking.pdf

Data from the 2022 IEPR supports this assertion, indicating that FCEVs typically cover distances ranging from 10,000 to 14,000 miles annually, surpassing the mileage of plug-in battery electric vehicles, which typically range from 6,000 to 9,000 miles per year. Additionally, the National Renewable Energy Laboratory IEPR presentation on the Clean Transportation Program benefits further provides enough data to assert that the retail hydrogen refueling network provides three times as much energy per public and ratepayer dollar invested compared to the publicly funded direct current fast chargers.

Unlike many clean technologies, hydrogen fueling infrastructure is well-positioned to achieve self-sustainability by the end of this decade. The Hydrogen Fueling Infrastructure Self-Sufficiency Report by CARB suggests that approximately $300 million more in funding is required to establish a self-sustaining market for light- and lighter-medium-duty fueling. Supporting this initial phase of passenger vehicle fueling infrastructure is a wise investment given the expected demand in the coming years.

In line with this, we share the 2022 Scoping Plan perspective that hydrogen refueling should be as accessible as conventional gas stations today.[16] An initial statewide network of 1,000 stations, catering to light and medium-duty vehicles, as envisioned in the "Hydrogen Fuel Cell Revolution" by the California Fuel Cell Partnership, would provide widespread geographic coverage, enabling 97% of disadvantaged communities and 94% of the overall population to access refueling within 15 minutes, with 60% being within a mere 6-minute drive. To meet the projected demand outlined in the Proposed Scenario, California would need to build more than 130 stations annually until 2045.

Moreover, fostering a robust FCEV market will offer an economic pathway for existing fueling stations, many of which are small, minority-owned businesses, to transition from traditional gasoline and diesel to hydrogen. Providing a viable transition path for these business owners and their employees is pivotal as we transition away from fossil fuels.

A significant portion of the medium-duty fleet currently relies on retail refueling infrastructure designed for light-duty vehicles. Considering this, the SB 1075 report should consider the benefits of directing future hydrogen refueling infrastructure grants toward addressing the needs of these medium-duty pickups and vans. Specifically, focusing on the ability to provide high flow refueling sessions of 10 kilograms or more per session would not only serve a broader range of customers but also enhance the reliability and resilience of the station network.

Regarding heavy-duty applications, the advantages of fuel cells, such as long-range capabilities and rapid refueling, make them an optimal choice for public transit and goods movement, particularly in regions with high temperatures. The Scoping Plan's projections for high fuel cell utilization in the heavy-duty vehicle segment align with the Hydrogen Fuel Cell Partnership's "Fuel Cell Electric Trucks: A Vision for Freight Movement in California and Beyond", which envisions establishing 200 strategically located heavy-duty stations by 2035 to serve over 70,000 fuel cell trucks.

However, the current allocation of zero-emission infrastructure funding provides less than 4% of every dollar for hydrogen fueling compared to charging, potentially jeopardizing the sufficiency of fueling infrastructure for fleets.

The CARB SB 1075 scenarios anticipate the use of fuel cell electric vehicles to reach over 100,000 in the next ten years and then double by 2040. This is more consistent with industry forecasts than the CEC

[16] https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf, Page vii

numbers presented in the IEPR workshop.  To reach these goals we need to ensure that we create reasonable approaches though policy vehicles without delaying this market traction.

An economic analysis conducted by Capitol Matrix in 2021[17] underscores that, with appropriate state support, the construction of 1,000 stations (800 for light-duty and 200 for heavy-duty) and associated production facilities could support between 2,280 and 3,720 jobs annually. Additionally, a growing number of permanent jobs would be created as construction concludes and new production facilities come online. Jobs related to the operation and maintenance of the expanded hydrogen fueling infrastructure are estimated to start at between 1,370 and 1,810 in 2023 and grow to between 12,010 and 13,460 by 2032. These positions come with an average annual salary of approximately $84,000 (excluding benefits), surpassing the private sector's average wage in California, which stands at $71,140 for all industries. The above-average rate is reflective of the numerous well-paying jobs encompassing engineering, construction, installation, equipment maintenance, and hydrogen testing. The job figures are expected to expand further as investments make hydrogen fueling infrastructure development sustainable, aligning with increasing state targets for zero-emission vehicles (ZEVs).

Supporting hydrogen mobility across all vehicle applications allows California to hedge its bets on two technologies with minimal cost impact. By doing so, the state significantly enhances its chances of achieving carbon neutrality, even if limitations or constraints arise in one technology, such as those related to raw materials, infrastructure, consumer adoption, public safety power shutoffs or blackouts, or cost concerns. Implementation of CARB's Innovative Clean Transit rule is showing increasing interest in fuel cells[18] as a zero-emission solution.

**Off-Road**

One of the earliest practical applications of hydrogen fuel cells found commercial success in forklifts and material handling equipment. Today, we witness the emergence of hydrogen's applicability in various off-road sectors. As outlined in the Proposed Scenario, there is a clear and growing demand for hydrogen in construction equipment, rail, maritime, aviation, and agriculture. In creating the first commercially viable market for hydrogen fuel cell technology, Plug Power has deployed more than 60,000 fuel cell systems and over 180 fueling stations, with its customers completing more than 55 million hydrogen fills into forklifts and other material handling equipment.[19]

Numerous new projects in these sectors are either nearing deployment, in active development, or have been publicly announced. These developments serve as reminders that careful coordination is imperative to align the rollout of diverse mobility solutions with the necessary fueling infrastructure and, increasingly, hydrogen production capacity.

Acknowledging the importance of advancing these sectors, we lend our support to the policy proposals that will enhance and expand off-road programs like FARMER, Carl Moyer, the Clean Fuel Reward Program, CAPP, and Low Carbon Transportation, including CORE.

The crucial need for mobile refueling solutions requires policy and incentive support. In the context of agriculture and construction, the transition to fuel cell technology for heavy machinery necessitates the availability of mobile refueling options. This requirement stems from the transient nature of the

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[17] Williams, B, Capitol Matrix Consulting, June 2021, Analysis of Proposed Income Tax Credit for Hydrogen Fueling Infrastructure Development

[18] https://ww2.arb.ca.gov/sites/default/files/2022-10/FCEB-Deployment-Map.pdf

[19] https://www.ir.plugpower.com/overview/default.aspx

equipment, which often operates at various project sites. Not to mention the benefits for ports, maritime, rail, and aviation operations. It's worth highlighting that "off-road vehicles and equipment are major contributors to pollution, accounting for almost three-quarters of fine particulate matter (PM) and one-quarter of nitrogen oxides (NOx) emitted from mobile sources in the U.S."[20] Despite this recognition, existing programs like FARMER and CAPP lack dedicated funding for mobile refueling solutions. Addressing this gap in future grant opportunities is imperative to facilitate the effective transition of off-road vehicles and equipment to zero-emissions hydrogen technology.

**Electric Sector Transformation**

As California advances towards a progressively decarbonized electric sector and invests in broad cross-sector electrification, the SB 1075 report must delve deeper into identifying the gas facilities that will retain critical significance in 2045. It is crucial to discern the type of investments that will remain viable in an ever-evolving energy landscape. In this context, we strongly urge CARB to acknowledge recent joint modeling efforts that underscore the pressing need for zero-carbon firm dispatchable generation as California heads toward complete decarbonization. While various alternative fuels may offer this crucial benefit, we emphasize that the California Energy Commission (CEC) has estimated capacity shortfalls of nearly 2,000 MW in the summer of 2022, surging to over 11,000 MW by 2025.[21] Such firm, dispatchable resources are indispensable not only to address immediate shortfalls but also to facilitate future decarbonized electricity generation.

Fuel cell systems represent a non-combustion distributed energy resource that operates effectively both behind-the-meter and in-front-of-the-meter. They possess the versatility to fulfill various requirements such as resilient capacity, baseload, permanent load reduction, peak shaving, and backup power. The largest utility-scale fuel cell system currently in operation boasts a capacity of 78.96 MW in Seo-gu, Incheon, South Korea.[22] CARB's Technology Clearinghouse database showcases the use of small-scale and large-scale electricity and combined heat and power (CHP) fuel cell systems across California and the United States.[23] These systems are proving invaluable for providing resilient primary and backup power.

Hydrogen-fueled linear generators are fully dispatchable and fuel-flexible, offering the ability to deliver clean, firm power cost-effectively. Modular and scalable, these generators can be deployed wherever demand arises, whether at a local or utility scale. Their fast-ramping capabilities, coupled with 24/7 load-following capacity, enable instantaneous responses to load fluctuations and grid outages caused by events like wildfires, extreme weather, or unforeseen disruptions.

Additionally, long-duration energy storage coupled with hydrogen-powered turbines will play a pivotal role in providing clean, dispatchable power and bridging the anticipated capacity gap identified by CARB. Current turbine technology can provide up to 450 MW of output per turbine, making it a necessary solution to address gigawatt-level capacity shortfalls while minimizing the impact on ratepayers. The

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[20] https://www.cleantech.com/decarbonizing-off-road-vehicles-an-emerging-challenge-and-opportunity-to-reach-net-zero-emissions/

[21] See California Energy Commission Staff Report: *Midterm Reliability Analysis* September 2021, CEC–200-2021-009 Available at: https://www.energy.ca.gov/sites/default/files/2021-09/CEC-200-2021-009.pdf

[22] Doosan, "World's Largest Hydrogen Fuel Cell Power Plant Jointly Built by *Doosan Fuel Cell Put into Service*, November 2, 2021. Available at: https://www.doosanfuelcell.com/en/media-center/medi-0101_view/?id=57

[23] California Air Resources Board Emergency Backup Power Options – Commercial, available at: https://ww2.arb.ca.gov/our-work/programs/public-safety-power-shutoff-psps-events/emergency-backup-power-options-commercial

adoption of hydrogen-capable turbine technology will prevent the deployment of stranded assets as California transitions to a zero-carbon grid. This not only yields emission reduction benefits but also long-term cost advantages due to the technology's flexible fuel capabilities.

Hydrogen stands uniquely positioned to offer zero-carbon firm dispatchable generation, both directly and through fuel cell systems, linear generators, and hydrogen-powered turbines. Therefore, we recommend that CARB includes an action plan to support the transition from fossil gas facilities to zero-carbon fuels.

Considering the evolving role of the gas sector in the broader energy landscape, this decision is timely. As highlighted in the Scoping Plan, the energy sector has undergone significant transformation over the last two decades. The capacity of intermittent renewables has grown exponentially, increasing from 1,924 MW in 2002 to 19,977 MW in 2020. [24] While this remarkable growth in intermittent renewable capacity suggests that a shift towards decarbonization is within reach, it has been accompanied by a significant rise in energy curtailment. Renewable energy often generates during periods of low demand, leading to a substantial increase in energy curtailments. According to the California Independent System Operator (CAISO), curtailments of wind and solar energy reached a record high of nearly 350,000 MWh in March 2021.[25] As depicted in Figure 2, renewable and clean hydrogen can harness this abundant renewable resource for later use in the power sector, even during different seasons. Simultaneously, it can displace fossil fuels in other sectors.

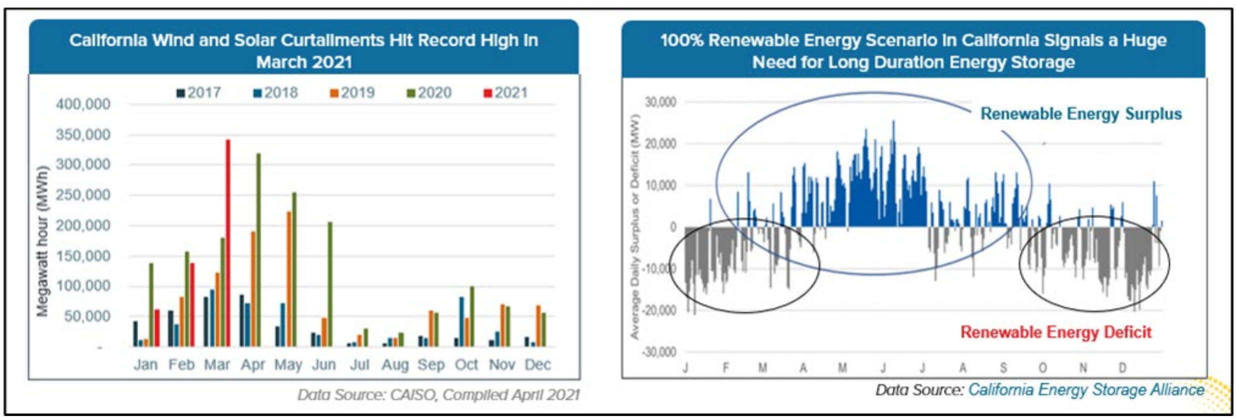


*Figure 2 Substantial storage capacity will be needed to support a 100% renewables scenario in California.*

As emphasized in the Scoping Plan, California's most stringent climate goal, outlined in SB 100 (De León, Chapter 312, Statutes 2018), mandates the complete decarbonization of 100% of retail electricity sales by 2045. To gain a comprehensive understanding of the investments, benefits, and costs associated with SB 100, CARB and the CEC have already released the SB 100 Joint Agency Report (JAR), which identifies various portfolios capable of meeting this target.

While the SB 100 Core scenario serves as a benchmark for achieving SB 100 goals, the JAR also identifies alternative scenarios based on specific sensitivity factors. The SB 100 Core portfolio involves selecting 145 GW of incremental utility-scale capacity additions by 2045, encompassing 70 GW of solar PV, 4 GW

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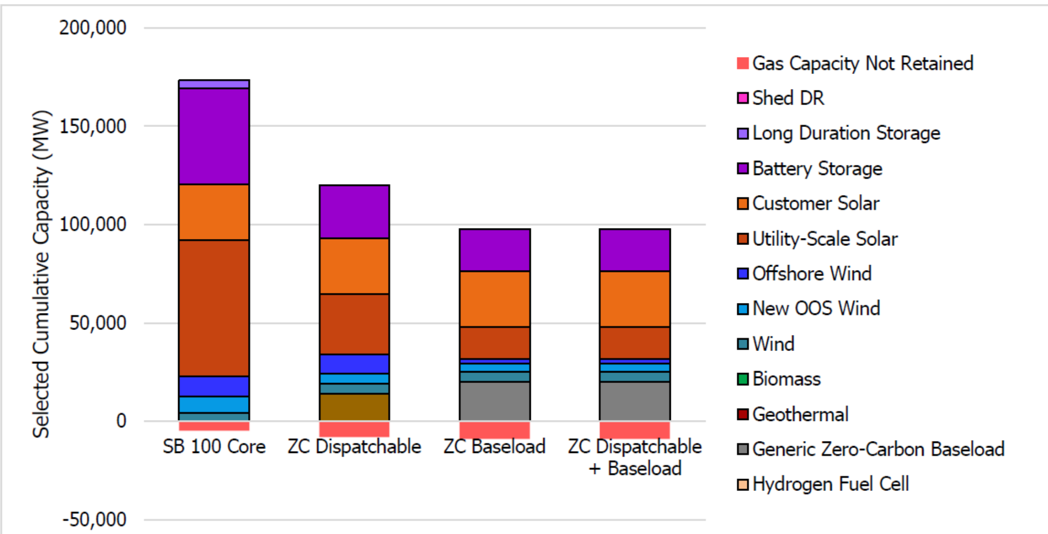
[24] See CEC, Electric Generation Capacity and Energy, available at https://www.energy.ca.gov/datareports/energy-almanac/california-electricity-data/electric-generation-capacity-and-energy

[25] CAISO Managing Oversupply. Data compiled April 2021. http://www.caiso.com/informed/Pages/ManagingOversupply.aspx#dailyCurtailment

of pumped storage, and 49 GW of battery storage.[26] This portfolio is estimated to incur a total resource cost of $66 billion USD by 2045.[27] To underscore the benefits of zero-carbon firm capacity, the report also explores a generic Zero-Carbon Firm Resource scenario. This scenario includes "generic dispatchable" resources and "generic baseload" candidate resources to represent a wide array of emerging technologies, including natural gas with 100% carbon capture, 100% clean hydrogen combustion, or other renewable fuels. When these zero-carbon firm resources are included, the model selects approximately 15 GW of either or both resources in total. Integrating these cost-effective zero-carbon firm resources significantly reduces the utility-scale solar and battery storage capacity selected by the model and trims the total resource cost in 2045 by $2 billion, or approximately 3%.[28]

These figures underscore that the cost of achieving policy targets is intricately tied to California's investment in zero-carbon firm assets, such as renewable and clean hydrogen.




Source: CEC staff and E3 analysis

*Figure 3 Cumulative Capacity Additions for SB 100 Core Scenario and Generic Zero-Carbon Firm Resource Scenarios in 2045*[29]

Given the imperative need for zero-carbon firm dispatchable generation and its cost-effectiveness, CARB should prioritize the transition of critical gas infrastructure to clean hydrogen to fulfill future electric generation requirements. Specifically, we propose that CARB and CEC should consider the needs of local load pockets, local reliability areas (LRAs), and hard-to-electrify customers and sectors to establish a comprehensive framework for identifying assets that warrant ongoing investment to repurpose them for clean hydrogen utilization. We must support the use of hydrogen to stabilize the grid when EV charging and intermittent renewables challenge grid operators, who need hydrogen for maximum flexibility, and this should be reflected in the IEPR and SB 1075 report.

Just as the 2021 SB 100 JAR suggests, promoting hydrogen today represents a cost-effective and fitting approach to ensure reliability while achieving California's decarbonization goals.

[26] 2021 SB 100 JAR, at 75.
[27] Ibid, at 83.
[28] Ibid, at 13.
[29] Ibid, at 13.

**Public Safety Power Shutoffs**
SB 1075 should consider the impacts of public safety power shutoffs that are creating a reliance on backup diesel generators to support buildings and even microgrids.[30] CARB's current Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines (Stationary Engine ATCM) allows the use of stationary emergency standby engines to provide electrical power when a facility experiences the loss of normal electrical service that is beyond reasonable control of the facility.[31]

There is a proliferation of diesel backup generators accelerating throughout California as we experience longer and more intense wildfire and drought seasons. In the South Coast Air Quality Management District alone, the number of backup diesel generators jumped by 22 percent from 2020 to 2021, while the proliferation of backup diesel generators in the Bay Area Air Quality Management District soared by 34 percent in less than three years.[32]

Diesel generators are a significant source of greenhouse gas and air pollution, releasing particulate matter, volatile organic compounds, and nitrous oxides, the combination of which creates smog, exacerbating respiratory illness and accelerating climate change. Since many diesel backup diesel generators are sited in low-income and disadvantaged areas, these communities face a disproportionately higher threat to public health. Recent analysis indicates that diesel-related pollution may trigger upwards of $136 million in health costs per year, due to increased mortality, heart attacks, hospital visits and other adverse consequences.[33] The South Coast Air Quality Management District has estimated that excess emissions from Diesel engines during PSPS events exceeded the total emissions from basin refineries.

Wildfire emissions are not accounted for in the 2022 Scoping Plan, but the particulate matter of diesel generator use is neither accounted for nor identified as a growing issue in California's decarbonization and air quality plans. Replacing backup diesel generators with clean alternatives like hydrogen fuel cells add flexible, firm distributed energy resources to California's energy portfolio. CARB should re-evaluate the current ATCM with an eye towards phasing out the use of diesel stationary internal combustion engines. In addition, SB 1075 report should suggest eliminating the inclusion of diesel ICEs in Title V permits and should further take steps to ensure that zero emission replacements for stationary Diesel engines are addressed as BACT and LAER throughout the state. Lastly, CARB, CPUC, CEC, and local districts should take steps to include zero emission technologies like fuel cells and linear generators in all SIPs and AQMPs as part of an expeditious program to reduce emissions.

**Economics of Curtailment**
In 2020, CAISO curtailed 1.5 million megawatt hours of utility-scale solar, or 5% of its utility-scale solar production.[34] In 2020, solar curtailments accounted for 94% of the total energy curtailed in CAISO.

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[30] https://www.governing.com/infrastructure/a-california-county-returns-to-power-thanks-to-its-microgrid
[31] https://ww2.arb.ca.gov/our-work/programs/emergency-backup-generators/about
[32] Steven Moss and Andy Bilich, M. Cubed, "Diesel Back-Up Generator Population Grows Rapidly in the Bay Area and Southern California" (2020). https://bit.ly/34qOr0b. BUGs have reached 7,360 MW of capacity in the South Coast AQMD and 4,840 MW of capacity in the Bay Area AQMD based on information for BAAQMD and SCAQMD. The report estimates an average capacity of 0.543 MW for units in SCAQMD and 0.628-0.642 MW for units in BAAQMD.
[33] Ibid
[34] https://www.eia.gov/todayinenergy/detail.php?id=49276#:~:text=In%202020%2C%20CAISO%20curtailed%201.5,total%20energy%20curtailed%20in%20CAISO

Renewable curtailment undermines California's policy supporting a zero-carbon electricity market but could be avoided if the renewable power that would otherwise curtail was used to produce electrolytic hydrogen. These curtailments will continue in frequency as renewable generation continues to be constructed. Even worse, absent clean firm long-term energy storage, the state will need to build far more renewable generation capacity than needed to ensure winter reliability, but this would lead to significant increases in electricity rates: ". . . wholesale electricity rates would increase by about 65% over today if renewable energy and currently available storage technologies alone were to be used to meet demand in 2045. Furthermore, even if consumers were willing to pay that premium, it may simply not be possible to build renewable facilities at this scale. Getting to nearly 500 gigawatts by 2045 would require expanding solar capacity at a rate 10 times higher than has ever been done before."[35]

Electrolytic hydrogen production would help solve both problems: Renewable electricity that would otherwise be curtailed would be used to produce clean electrolytic hydrogen. That renewable and clean hydrogen would be available to produce electricity in the winter. This will help reduce or eliminate renewable curtailment, avoid the need to over-build renewable generation capacity, and ensure reliability 12 months a year, without regard to time of day, cloud cover, or weather conditions.

**Pipelines Enable Scale**

CARB, CPUC, and CEC should provide a strategic vision in the SB 1075 report of how the gas pipeline network will evolve in line with the state's climate goals. This will help CARB address the many decisions about gas investments that will build toward a zero-carbon energy system. CARB should begin by setting an overarching goal with clear targets to guide common carrier gas pipeline decarbonization planning in the context of California's climate ambitions and set clear criteria to ensure a robust assessment of alternative solutions to traditional infrastructure needs. Doing so will send clear signals to utilities to maintain system safety while transitioning the natural gas pipeline network to a hydrogen pipeline network to support those hard-to-abate sectors that require an alternative to electrification.

In future years, a common carrier hydrogen pipeline network will be needed to serve power generation, long-haul trucking corridors, air- and seaports, and connect industrial hydrogen demand with supply. This backbone will require substantial hydrogen volumes, and to achieve this need, natural gas pipelines will need to be retrofitted for 100% hydrogen transport or new hydrogen-dedicated pipelines will need to be constructed. Having this common carrier hydrogen pipeline network in place will enable more rapid scaling of hydrogen producers who are more likely to build scaled systems where the capability exists to transport hydrogen at scale to the broadest set of end-users. Without the ability to transport hydrogen at scale, hydrogen producers will be more prone to develop sub-scaled projects that serve a more localized need. Accordingly, early investments in hydrogen delivery infrastructure will play a critical role in catalyzing zero-carbon fuel development.

Furthermore, some hard-to-abate sectors such as agriculture, transportation, shipping, industry, and aviation are making long-term investments today. They must know if clean hydrogen and hydrogen delivery network will be in place before said investments. Tackling the hard-to-abate sectors early on is essential as industry and transportation emissions represent most of the remaining emissions that California will ultimately need to tackle. Overall, investment in hydrogen pipeline infrastructure will be required to help enable industry and heavy-duty transport to decarbonize to manage costs and bring more stability to the sectors that are particularly exposed to the energy transition.

[35] https://issues.org/california-decarbonizing-power-wind-solar-nuclear-gas/

**Agriculture and Green Ammonia**

The current emissions inventory for California falls short in capturing the comprehensive greenhouse gas (GHG) emissions impacts arising from the agricultural sector. The Scoping Plan primarily concentrates on the GHG consequences of agricultural energy consumption within California's borders. Regrettably, it overlooks the carbon emissions embedded in the ammonia used in the production of fertilizer for the state's crops.

Ammonia (NH3) is a globally traded commodity, with approximately 80% of its global production dedicated to fertilizer production. Notably, the production of ammonia relies on gray hydrogen, generated from fossil fuels, and atmospheric nitrogen. California does not domestically produce ammonia; instead, it imports ammonia manufactured from fossil fuels, often transported via rail or ships to the Port of Stockton. Importantly, ammonia production in North America results in the emission of 2.129 tons of carbon dioxide per ton of ammonia produced.[36]

For context, California's import of 0.75 billion kg of ammonia in 2018 was responsible for approximately 1.6 billion kg of CO2 emissions.[37] This estimate, however, underestimates the true impact, as it does not account for the emissions generated during shipping or rail transport. Consequently, the omission of embedded emissions from ammonia imports portrays the agricultural sector as one of the lowest GHG emitters, despite its substantial contributions. Had these emissions been incorporated into the Scoping Plan, the agricultural sector's GHG contributions would have been significantly higher.

Furthermore, while the Scoping Plan advocates for electrification goals, such as 25% of energy demand by 2030 and 75% by 2045, it tends to presuppose electrification as the sole solution. While we support electrification, we recommend that the agricultural sector's goals are established based on specific decarbonization objectives, without preemptively determining the solution. As highlighted earlier, the primary driver for decarbonizing agriculture lies in transitioning from fossil fuel-derived ammonia to renewable or green ammonia. While electrification may suit other energy needs in agriculture, certain end uses may not be easily electrified. Therefore, renewable fuels, including green hydrogen and its derivatives, should be permitted to compete in these cases.

Promisingly, the scale of renewable hydrogen production is increasing, making cost-competitive green ammonia a feasible reality. The recent surge in fossil fuel prices, exacerbated by global events such as the war in Ukraine, has driven up ammonia prices, closely linked to natural gas prices due to hydrogen's significant role in ammonia production costs. Consequently, the cost of anhydrous ammonia has surged to all-time highs.[38]

Green ammonia production from green hydrogen is rapidly scaling up worldwide, with numerous projects in development. These projects, funded by organizations like Copenhagen Infrastructure Partners, highlight the potential of green ammonia in the global energy landscape.[39] For instance:

- Host (Denmark): 1 GW electrolysis powered by offshore wind, solar, and grid sources, producing 200-300 kilo tons/yr. of green ammonia for fertilizer. Completion by 2023.

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[36] Brown, Trevor, et al. "Ammonia Production Causes 1% of Total Global GHG Emissions." AMMONIA INDUSTRY, 31 Jan. 2019, www.ammoniaindustry.com/ammonia-production-causes-1-percent-of-total-global-ghg-emissions/

[37] CDFA - IS - Fertilizer Tonnage Report by Year (ca.gov)

[38] https://www.californiaagtoday.com/the-story-of-rising-fertilizer-prices/

[39] Source: Copenhagen Infrastructure Partners interviews and website

- Iverson (Norway): 240 MW electrolysis fueled by wind and solar, producing 600 metric tons/day of ammonia as a global commodity. Expected by 2024.
- Murchison Renewable Hydrogen Project (Australia): 3 GW electrolysis powered by wind and solar, producing 1.7 million tons/year of ammonia for export to Asia for power production. Targeted for 2030.
- HNH Energy (Chile): 5 GW electrolysis driven by wind energy, producing green ammonia for fertilizer and shipping fuel supply. Expected by 2029.
- Madoqua Project (Portugal): 400 MW project connected to the grid, with wind and PV sources, producing green ammonia for chemicals, fertilizer, and potential shipping fuels. Anticipated by 2026.

Considering these global trends, the time is ripe to develop locally produced renewable alternatives to fossil-based ammonia production. This transformation will empower California's farmers to decarbonize their crops, enhance yield, and reduce fertilizer costs tied to fossil fuel volatility. Such a shift offers numerous benefits:

i. Energy and Food Security: Enhancing energy and food security in California.
ii. Economic Diversification: Diversifying California's central valley economy and reducing capital outflows to regions like Texas and gray ammonia producers in the Gulf of Mexico.
iii. Land Repurposing: Repurposing agricultural land for less water-intensive, high-value renewable energy and green hydrogen production.
iv. Water Infrastructure: Leveraging demand for green hydrogen and green ammonia to support new municipal water infrastructure projects, enhancing water security.
v. Maritime Fuel: Positioning California to supply green ammonia as a carbon-free alternative to diesel and bunker fuel for maritime shipping.
vi. Leadership in Hydrogen: Establishing California as a national leader in green hydrogen and green ammonia production, with both domestic and export potential.[40]
vii. Highly Skilled Jobs: Generating highly skilled, high-paying jobs in disadvantaged areas, supporting economic growth.[41]
viii. Economic Impact: Expanding the economic contributions of the fertilizer industry to California's economy.[42]

California, can provide essential leadership in realizing the profound potential for deep decarbonization of the agricultural industry. This endeavor commences with accurately tracking emissions from the agricultural sector, including embedded emissions in imported fertilizers. Additionally, the SB 1075 report can guide and facilitate ecosystem stakeholders to stimulate demand for decarbonized alternatives.

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[40] https://www.jera.co.jp/english/information/20220218_853

[41] The Fertilizer Institute. 2020. "Fertilizer Grows Jobs Feeding Crops While Growing the U.S. Economy". [online] Available at: <https://tfitest.guerrillaeconomics.net/res/National%20Infographic.pdf> [Accessed10 December 2020].

[42] The Fertilizer Institute. 2020. "Fertilizer Grows Jobs Feeding Crops While Growing the U.S. Economy". [online] Available at: <https://tfitest.guerrillaeconomics.net/res/National%20Infographic.pdf> [Accessed10 December 2020].

As green hydrogen gains prominence as a transformative commodity in the energy market, it becomes increasingly crucial to plan for and capitalize on the substantial benefits of including comprehensive agricultural decarbonization in the Scoping Plan.

**Embracing the United States' Hydrogen "Earthshot" and California's Leadership Role**
In a momentous announcement on June 7, 2021, Secretary Granholm unveiled the federal government's Hydrogen Energy "Earthshot" initiative, setting an audacious goal to reduce the costs of clean hydrogen to just $1 per kilogram within a decade. This ambitious pricing target underscores the pivotal role of hydrogen as an energy carrier in the journey towards decarbonization. It also acknowledges that California's climate-conscious allies in Asia and Europe are significantly ahead in their plans and execution of hydrogen deployment within their carbon reduction strategies. Achieving the milestone of $1 per kilogram for clean hydrogen surpasses the cost reductions necessary to not only compete directly with existing fossil fuel resources but also makes hydrogen a more cost-effective option than retail electricity in California.

The Hydrogen Energy Earthshot initiative serves as both a wake-up call to our nation and a resounding market signal to industry stakeholders. California, in a similar vein, must send strong market signals and cultivate a stable policy environment that fosters investment. The world often looks to California not just for leadership but also as a valuable partner in the realm of decarbonized energy and mobility. Our climate allies are already leading the charge, and the time has come for California to wholeheartedly embrace its leadership role. Constructing a thriving hydrogen economy is a collective endeavor, one that can be developed through collaboration, innovation, and sustainable policies. With the right approach, we can harness a zero-carbon, domestically sourced energy resource that, when coupled with zero-carbon end uses, can replace fossil fuels on a one-to-one basis. Crucially, this can be accomplished without placing undue expectations on mass behavioral changes from the public, all while facilitating a just transition for numerous businesses and hundreds of thousands of Californians.

Over thirty-five countries worldwide have recognized the substantial role that hydrogen plays in achieving national climate change emissions reduction objectives and striving for carbon neutrality. These nations have released comprehensive hydrogen strategies to chart their course. The hydrogen industry is investing billions into establishing a hydrogen-based economy that will facilitate the adoption of hydrogen as a versatile energy carrier. A July 2021 report by the Hydrogen Council revealed that globally, 359 large-scale hydrogen projects had been announced at that time. These projects, spanning the entire value chain, accounted for an estimated $500 billion in investments through 2030. Subsequent announcements have likely increased these figures. Nevertheless, there is more work ahead, and the Scoping Plan presents immediate opportunities to broadcast investable signals to the private market, channeling capital towards the strategic investments needed for California's sustainable future.

**Addressing the Misrepresentation**
The SB 1075 and IEPR proceedings should ensure that representation from multiple, credible sources of scientific and economic analysis of hydrogen program are empaneled to address design features such as time matching, deliverability, and requirements for new build of input energy resources. T recent IEPR workshop allowed presentations by entities disseminating information on these topics and representing their opinions as settled fact while often citing only single sources for their claims. There is no scientific consensus on these policies. It does not serve the State's decision-making processes to singularly present one perspective without hearing from both sides and proliferates the conveyance of false information to the public.

We urge CARB, CEC, and CPUC to contextualize the concerns raised with the scale of the actual issues in mind including whether these concerns are correlation or causation. For example, the issues of leakage and indirect greenhouse gas impacts have been raised with a presenter indicating that hydrogen is a climate pollutant. However, in the presented study and all those that preceded it methane is the pollutant with the global warming impact. An equally fair assertion is to claim that capturing biogenic methane would reduce this interaction and have a greater impact on global warming that policies that prevent the proliferation of hydrogen or even disallowing mitigation of methane by incorporating it into a renewable hydrogen definition.

Regardless, previous studies discussing this hydrogen, OH radical interaction and how it may prolong methane's persistence in the atmosphere tended to contextualize their finding. As we argued in our December 7, 2022, IEPR Comments, "The mechanisms described in 2006[43] and 2021 by Dr. Derwent, reiterated in the IEPR cited study by the Environmental Defense Fund, about how hydrogen in the atmosphere can have an indirect global warming impact are accurate. However, just as oxygen interacts with criteria pollutants in the formation of tropospheric ozone – hydrogen is not a greenhouse gas or climate pollutant because it interacts with methane pollution."

Hydrogen can react with chemical species that would otherwise react with and eliminate atmospheric methane, a global warming gas. This effect can increase the persistence of methane in the atmosphere thereby creating a global warming impact. In addition, hydrogen can react in the upper atmosphere to form water, which also has a global-warming impact.

However, the magnitude of the impact of these mechanisms depends on the amount of hydrogen and methane in the atmosphere. Managing methane leakage, as required in SB 1383 (Lara, Chapter 395, Statutes 2016), and implemented in CARB's Short-lived Climate Pollutant Strategy, can eliminate most of the indirect impacts of hydrogen leakage.

***If hydrogen was used in substitution for current fossil fuels that release methane, CO2, and other GHG emissions into the atmosphere and it leaked at a "reasonable" rate of 1%, utilizing hydrogen would reduce climate impacts by 99.4%; even if it leaked at an "unreasonable" rate of 10% it would still reduce climate impacts by 94%.[44] IEA's high-risk scenario predicts a 5.6% leakage indicates a 96.6% reduction in GHG emissions from leakage if decarbonized hydrogen is displacing fossil fuels.[45]***

We agree that leakage is expensive, and the industry is working to ensure that losses are minimal for economic reasons, however the environmental risks are overstated, and absent context will be misconstrued. We can engineer our way to reducing the economic issue; there are coatings and solutions that mitigate those concerns. Utilization of a dedicated or retrofitted pipeline will further reduce any leakage risks, emphasizing the need to develop policy and act quickly on constructing this network. As infrastructure for the hydrogen economy matures, leakage risks are minimized, and biogenic methane will be a valuable feedstock for renewable hydrogen production – the combination of these factors supports maturation of hydrogen infrastructure to rapidly decarbonize gas infrastructure."

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[43] Derwent, Richard, et al.,2006. Global Environmental Impacts of the Hydrogen Economy

[44] Ibid

[45] Fan, Zyhiyuan, et al., July 2022 Columbia Study of Hydrogen Leakage,

Furthermore, the discussion about hydrogen leakage typically involves measuring how much hydrogen gas (or its volume) leaks compared to other gases, with methane being the most common point of comparison. On the other hand, when it comes to climate modeling, the focus is on assessing the impact of various compounds in the atmosphere in terms of their mass and comparing their radiative forcing effects to a unit mass of $CO_2$. In the case of hydrogen, its Global Warming Potential (GWP) is expressed as the ratio of the radiative forcing caused by a kilogram of hydrogen to that caused by a kilogram of $CO_2$.

If we examine the implications of a statement from the leakage literature that says, "hydrogen leaks three times faster than methane." This essentially means that three times as many moles of hydrogen leak compared to one mole of methane. So, if we want to compare the amount of hydrogen that enters the atmosphere to the amount of methane that enters, we can calculate it as follows:

[(3 moles of $H_2$) / (1 mole of $CH_4$)] * [(2 kg of $H_2$ per mole of $H_2$) / (16 kg of $CH_4$ per mole of $CH_4$)] = 0.375 kg of $H_2$ per kg of $CH_4$ leaked into the atmosphere.

When climate literature suggests a leakage rate (in terms of mass) for hydrogen that is 10 times greater than methane, or even 3 times greater than methane, it is significantly higher than what the leakage literature indicates or supports. Needless to say, while we do not disagree with the chemical reaction, we do disagree with how the findings are being presented in order to delay action and policy that would allow hydrogen to be incorporated fairly into a decarbonized economy.

This is further complicated by the recent publication of articles[46],[47] identifying naturally occurring hydrogen produced and emitted from the earth's crust. The extent of this production and leakage is unknown but the scale of this leakage further changes the assertions of those who want to link hydrogen to extending the atmospheric impacts of methane.

All this is to say, the science is not settled as was asserted by an IEPR panelist and the SB 1075 report should closely examine the assumptions, conversion factors, claims, and other factors to contextualize the potential risks and rewards.

**Conclusion**

We respectfully request CARB, CPUC, and CEC to consider our comments and potential environmental and economic benefits of supporting the proliferation of decarbonized and renewable hydrogen as a tool to achieve California's energy and climate goals. A new energy system, underpinned with the flexibility of hydrogen will leverage existing assets for reliability, resiliency, and affordability while supporting deep penetration of renewables with a zero-carbon energy carrier allowing for a true 24/7 approach to renewable and clean energy. Hydrogen scales to serve the demands of the lives and livelihoods of Californians. This fully integrated approach is leveraged through industry-to-industry transitions and cross-sectoral synergies that will accelerate emission reductions across the economy while maintaining and creating high-road employment opportunities with existing employers. Allowing sectors to transition, not employees whose current day skills are directly translatable to the hydrogen economy of tomorrow. California needs a vision for carbon neutrality – high hydrogen utilization

[46] https://www.science.org/content/article/hidden-hydrogen-earth-may-hold-vast-stores-renewable-carbon-free-fuel
[47] https://www.pv-magazine-australia.com/2023/09/12/nasa-finds-hydrogen-emitting-fairy-circles-in-wa/

throughout the economy will have significant environmental, health, equity, and economic benefits for all Californians.

We request that the agencies align around inclusive energy policy that supports all sectors with hydrogen. The SB 1075 report, the IEPR and the Hydrogen Market Development Strategy should be aligned to allow California to leverage federal and state funding for air quality, economic and jobs benefits and to acknowledge and include hydrogen as a required pathway to meet the Scoping Plan objectives for decarbonization and the requirements of nearer term mandates. There are complex and sometimes layered factors that the SB 1075 report and IEPR will need to balance but it is important to have a multi-factor techno-economic and environmental analysis which includes reliability, resilience, sustainability, system efficiency, and emission reductions that are cost-effective and technologically feasible.

On behalf of the California Hydrogen Business Council and California Hydrogen Coalition, we thank you and we look forward to discussing further. If you have any questions please contact Teresa Cooke, Katrina Fritz, and Mikhael Skvarla

Sincerely,

Katrina M. Fritz
Executive Director
California Hydrogen Business Council

Teresa Cooke
Executive Director
California Hydrogen Coalition

cc: Members, California Air Resources Board
Commissioners, California Energy Commission