June 24, 2022

The Honorable Liane Randolph
California Resources Board
1001 I Street
Sacramento, CA 95814

Re: Draft 2022 Scoping Plan

Dear Chair Randolph,

On behalf of the undersigned associations, unions, and companies we thank the California Air Resources Board (CARB) for the time and effort taken to develop the Draft 2022 Scoping Plan (Scoping Plan or Proposed Scenario). It is clear this effort was undertaken by dedicated staff who care about the future of California and its residents. This 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 in the Proposed Scenario is significant and will provide meaningful emissions reductions throughout every segment of the economy. We believe a strong vision for hydrogen will enhance the Scoping Plan's 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.

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, as described in the Proposed Scenario, 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 supported by hydrogen will enhance the future of California while achieving climate and air quality goals. *The Scoping Plan outlines the need for hydrogen across the economy and achieving it will require dedicated policy and infrastructure support. 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.*

A Virtuous Cycle

Hydrogen is the most abundant element in the universe. Harnessing the molecule (H_2) as an energy carrier is the next step in the energy evolution leading to a cleaner, healthier, and more sustainable environment. The versatility of hydrogen production, storage and end-uses provides many of the same benefits as our fossil-based energy system as it relates to productivity, reliability, resiliency, and economic benefits without the negative environmental consequences. These findings are supported by the Intergovernmental Panel on Climate Change (IPCC), an academic advisory body to the United Nations.

For decades, Californians sought to "close the loop" on waste. Whether it be organic waste or curtailed renewable energy, hydrogen is the answer to some of our greatest clean energy and transportation challenges. The slogan, "reduce, reuse and recycle" can be applied to the developing hydrogen economy.

Electrolysis of sustainably sourced water to hydrogen is needed to underpin the economics of renewable electricity through 100% utilization of wind and solar assets. Electrolysis will be a predominant source for hydrogen and will often be paired with dedicated "behind the meter" renewable electricity generation. Beyond fuel production, we envision a future where we manage electrolyzer loads to support the grid during peak demand. Renewable and clean hydrogen will be used in turbines and fuel cells to provide firm power and peaking power to the grid. Excess hydrogen will be stored in geologic formations and compression tanks, to be dispatched when the grid or pipeline requires it. Months of excess energy, not hours, will be available and provide benefits to Californians without requiring reductive behavioral and lifestyle changes to achieve our climate goals.

Upcycling biomethane, biomass, and even non-recycled municipal waste feedstocks to hydrogen presents a tremendous opportunity to deliver on the mandated emissions reductions required by SB 1383 (Lara, Chapter 395, Statutes 2018) and the Short-Lived Climate Pollutant Reduction Strategy. Hydrogen mitigates anthropogenic emissions by utilizing emissions from landfills, Publicly Owned

Treatment Works (POTWs), and disposal of biomass, including agricultural waste streams and those from wildfire mitigation activities, to produce low-to-negative carbon hydrogen, while avoiding undue costs to ratepayers of those public goods.

Steam methane reformation of biogas/biomethane is a high efficiency low-carbon pathway for mitigating methane emissions from anthropogenic sources like landfills, dairies, and POTWs, while also creating favorable economics for the anerobic digester capacity needed to achieve our statutory organic waste diversion goals and Short-Lived Climate Pollutant Reduction Strategy, an imperative highlighted in this Scoping Plan. Additionally, newer hydrogen production technologies like steam/CO_2 reforming, which produces hydrogen without combustion, also utilizes anthropogenic sources as well as municipal solid waste to produce negative carbon hydrogen for use in our energy and transportation sectors. Further, advances in renewable dimethyl ether, ammonia, and other energy dense molecules as hydrogen carriers can use existing infrastructure to reduce the delivered cost of hydrogen. Repurposing existing and new steam methane reformation facilities with renewable feedstock is a first step to cost-effectively decarbonizing hydrogen production that will encourage the uptake of fuel cells. In turn, ramping up market demand for renewable and clean hydrogen will create an initial virtuous cycle.

Thermochemical conversion of biomass to hydrogen is another way to manage the waste from forestry and agricultural operations. Under this scenario, hydrogen provides favorable economics to mitigating wildfire risks while lowering emissions by eliminating the open combustion-based practices highlighted by the state procurement of incinerators in recent budgets for CalFire. A study from Lawrence Livermore National Laboratory states that "[g]asifying biomass to make hydrogen fuel and CO_2 has the largest promise for CO_2 removal at the lowest cost and aligns with the State's goals on renewable hydrogen."[1]

Each of these clean hydrogen production pathways are necessary to achieve carbon neutrality. All three provide critical co-benefits and "close the loop" on maximizing large-scale renewable energy projects and minimizing dangerous short-lived climate pollutant emissions. The creation of a high-value energy carrier for the transportation, industrial, agricultural and electricity sectors also manage investment risk leading to better economic outcomes.

In the transition to carbon neutrality, with hydrogen as a key resource, California can leverage the skills and infrastructure from our robust oil, gas, and utility sector as a backbone for distribution of renewable and clean hydrogen throughout the state. Starting with a blending standard to lower the carbon content of our natural gas supply and the buildout and/or conversion of some dedicated hydrogen pipelines in industrial clusters, we can fully transition the energy utilized by industry, all while maintaining the existing workforce. The virtuous cycle that will accelerate through reusing and retrofitting existing pipelines throughout the state will be the backbone for unlocking scale while maintaining high-road jobs of pipefitters, laborers, operating engineers, steelworkers, and utility workers that would not otherwise be replaced in a decarbonized economy without hydrogen. Repurposing infrastructure also preserves significant ratepayer investments in the multibillion-dollar pipeline network while allowing the rapid scaling of hydrogen production and off-takers throughout the state. The transition of pipeline infrastructure is critical to creating a virtuous cycle where diverse production pathways of decarbonized

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

hydrogen leads to diverse off-takers resulting in sector-to-sector transitions. This avoids the environmental and economic impacts of leakage that will result if we do not provide viable and economically sound solutions for every segment of every sector.

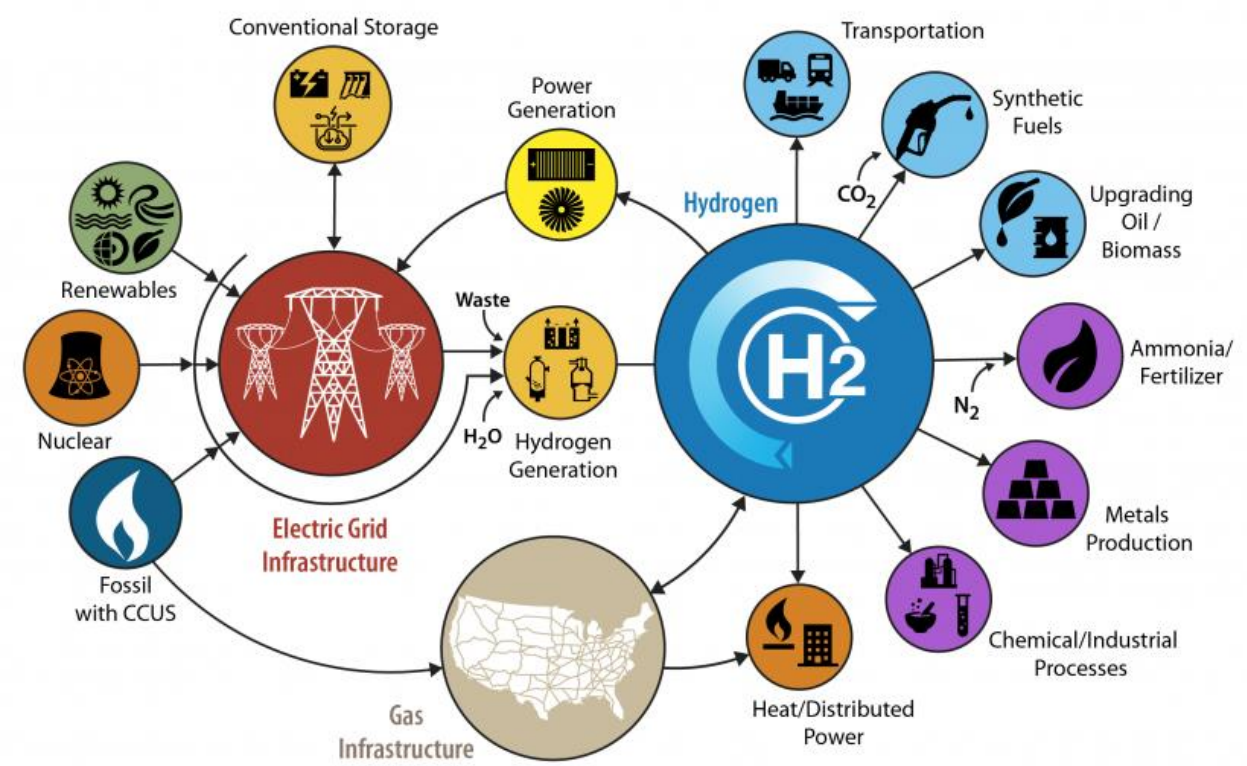

Figure 1 https://www.energy.gov/eere/fuelcells/h2scale
This is an illustration from The Department of Energy depicting sector-to-sector synergies in a hydrogen economy, but it is important to note this is not comprehensive of all the emerging production pathways or end uses, and some pathways will not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

Transportation Sector

The Proposed Scenario has a significant, though understated, role for fuel cell electric vehicles (FCEVs) across weight classes and vocations. As it relates to light-duty vehicles, the Scoping Plan modeling results indicate at least 3 million fuel cell passenger vehicles by 2045. Given the advantages fuel cell vehicles offer for those living in multi-family dwellings, those who require fast-refueling and larger vehicles, we think the market will be much greater than modeled in the proposed plan. The Mobile Source Strategy forecast of fuel cells being upwards of 20% of the passenger vehicle market is a more likely scenario. When considering our super-commuters, construction and agricultural workforce, and the growing role of transportation networking companies, demand for fuel cell vehicles will increase rapidly once sufficient infrastructure exists to allow statewide refueling. Data collected by the California Energy Commission supports this claim as, on average, FCEVs are driven between 10,000-14,000 miles per year while plug-in battery electric vehicles are driven between 6,000-9,000 miles per year.

Unlike many clean technologies, hydrogen fueling infrastructure is well-positioned to become self-sustaining at the end of the decade. Based on the ARB's Hydrogen Fueling Infrastructure Self-Sufficiency Report[2], approximately $300M more is needed to create a self-sustaining light- and lighter medium-duty fueling market. Funding support to "finish the launch" of the passenger vehicle fueling market is a prudent investment given the demand anticipated over the next several years. To that end, we agree that *"…hydrogen transportation refueling must be as accessible as today's corner gas stations…"*[3] An initial statewide network of 1,000 stations, serving the light and medium duty vehicles, envisioned in the *Hydrogen Fuel Cell Revolution* by the California Fuel Cell Partnership, would provide geographic coverage to allow 15-minute access for 97% of disadvantaged communities and 94% of the overall population with 60% being within 6-minutes of a station. On a linear trajectory, California will need to build more than 130 stations per year, until 2045, to meet projected demand in the Proposed Scenario.

In the early deployment of light-duty hydrogen, we are already seeing promising reductions in station costs while capacities are doubling. The cost of these stations is and will continue to decline while capacity and number of fueling positions per station will grow. Additionally, new fueling technologies are entering the sector, further lowering station capex over time.

Additionally, a robust FCEV market will provide an economic pathway forward for existing fueling stations, which number in the several thousands, to transition from gasoline and diesel to hydrogen. Many fueling stations are predominantly small, minority-owned businesses. Having a viable pathway for these business owners and their employees will allow them to keep their businesses as we transition away from fossil fuels.

As it relates to heavy-duty applications, the vehicle weight advantage associated with long-range and rapidly refueling benefits of fuel cells will allow existing commercial transportation business models to be maintained as they offer the same operational efficiency. For these reasons, FCEVs are an optimal option for public transit and goods movement, particularly in high-heat regions. We were pleased to see the Scoping Plan's projections of high fuel cell utilization on the heavy-duty vehicle segment and to that end, support the California Fuel Cell Partnership's California Road Map[4] of 200 strategically located heavy-duty stations by 2035 to serve over 70,000 fuel cell trucks.

However, current zero-emission infrastructure funding provides less than $0.07 of every dollar for hydrogen fueling compared to charging, putting fleet operators at risk of insufficient fueling infrastructure. We support the Scoping Plan strategy to "provide capacity credits for hydrogen and electricity for heavy-duty fueling.[5]" Due to the higher capacity of HD stations, we ask that for these applications, the capacity limit for HD stations be scaled to the needs of this market segment. Crediting should be proportional to capacity to ensure that the business case for the station is hydrogen dispensing and not crediting. We ask that the program have similar bounds to the light-duty stations, using a limit of an additional 2.5 percent of deficits in the prior quarter for pathway approvals to be granted.

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[2] https://ww2.arb.ca.gov/sites/default/files/2021-10/hydrogen_self_sufficiency_report.pdf
[3] https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf, Page vii
[4] https://www.fuelcellpartnership.net/sites/default/files/Roadmap-Progress-Report2014-FINAL.pdf
[5] 2022 Draft Scoping Plan, page 154

We believe expanding the HRI Pathway to include HD HRS can provide an effective incentive for expanding zero-emission vehicle infrastructure while remaining consistent with the LCFS policy intent by accomplishing the following during the early years of HD FCEV deployment:

- partially offset the initial lower utilization of hydrogen refueling stations, thereby supporting refueling network development to increase the availability of hydrogen and ensure vehicles are supported;
- enable efficient development of hydrogen refueling stations at a sustained pace and scale to achieve significant cost reduction, for efficient use of public and private funds and reducing the cost of low-carbon fuels for Californians;
- enable the incentive structure already in place in the LCFS to reduce the carbon intensity of hydrogen through increasing renewable content;
  become self-balancing and sun-setting, with credit generation through the HRI pathway decreasing over time as hydrogen sales and station utilization increase;
- ensure best-in-class carbon intensity and infrastructure quality through eligibility conditions;
- ensure no material or unintended impacts to the overall LCFS policy and stakeholders through fixed limits on duration, infrastructure capacity, and credit generation.

We look forward to working with CARB staff on the details of this change to the Low Carbon Fuel Standard program that will enable the build-out of a statewide heavy-duty station network.

In an economic analysis done by Capitol Matrix in 2021[6], with appropriate state support, the construction of 1,000 stations (800 LD and 200 HD) and associated production facilities will support between 2,280 and 3,720 jobs annually. In addition, a growing number of permanent jobs will be created as construction is completed and new production facilities come online. Jobs supported by operations and maintenance of the expanded hydrogen fueling infrastructure start at between 1,370 and 1,810 in 2023 and rise to between 12,010 and 13,460 by 2032. The jobs created by the construction and operation of a hydrogen fueling infrastructure would average about $84,000 per year (excluding benefits). Average pay of permanent jobs tied to the operations and maintenance of production hydrogen fueling facilities would be over $91,000 per year. These averages compare favorably to the $71,140 private sector average wage for all industries in California. The above-average rate reflects the large number of good-paying jobs involved in engineering, construction, installation, equipment maintenance, and hydrogen testing. Assuming investments are successful in making hydrogen fueling infrastructure development sustainable, job totals for both construction and operations will grow substantially in the future as the FCEV market continues to expand in line with increasing state targets for ZEVs.

Supporting hydrogen mobility across all vehicle applications allows California to bet on two technologies with minimal cost impact. In doing so, California can significantly increase the chances of achieving carbon neutrality if limits or constraints on one technology come to fruition (e.g. raw materials, infrastructure, consumer adoption, public safety power shutoffs or blackouts, or cost).

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

Off-Road

One of the earliest commercial applications of hydrogen fuel cells is the use in forklifts and material handling. Other off-road uses are emerging and as described in the Proposed Scenario, there will be increasing and significant demand for hydrogen in construction equipment, rail, maritime, aviation, and agriculture. Several early projects in these sectors are nearly ready for deployment, in development or have been announced – they remind us that further preparation is required to synchronize the rollout of all forms of mobility with fueling infrastructure *and, increasingly,* hydrogen production.

Recognizing the need to further these sectors, we support the Proposed Scenario's intent to improve and expand off-road programs like FARMER, Carl Moyer, the Clean Fuel Reward Program, CAPP, and Low Carbon Transportation, including CORE.

Missing from the Scoping Plan is the need for mobile refueling. Agriculture and construction will need mobile refueling options as heavy machinery transitions to fuel cell technology. Mobile refueling is essential for off-road vehicles in their transition to zero-emissions due to the transitory nature of the equipment, in addition to operating at various project sites. "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 (NO_x) emitted from mobile sources in the U.S."[7] Despite this recognition, there are no funds in the FARMER or CAPP program for mobile refueling and this should be addressed in future grant opportunities.

Electric Sector

In general, we believe that CARB is correct in starting to determine an action plan for the future of electricity generation needs. As the State moves toward an increasingly decarbonized electric sector and invests in cross-sectoral electrification, this Scoping Plan should better understand which gas facilities will remain critical in 2045 and what type of investments will prove useful in a rapidly changing energy landscape. In this context, we urge CARB to recognize the findings of recent joint modeling efforts, indicating a significant need for a zero-carbon firm dispatchable generation as California moves toward full decarbonization. While several alternative fuels could provide said benefit, we consider that The California Energy Commission (CEC) estimates capacity shortfalls of nearly 2,000 MW in the summer of 2022 and over 11,000 MW in 2025.[8] Firm, dispatchable resources are needed to address shortfalls today, to enable future decarbonized electricity generation.

Fuel cell systems are non-combustion distributed energy resources operating both behind-the-meter and in-front-of-the-meter that can address requirements for resilient, firm capacity, baseload, permanent load reduction, peak shaving and backup power. The U.S. Department of Energy recently cited that more than 6 GW of stationary fuel cells are installed around the world.[9] The largest utility-

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

[8] 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

[9] Reference to be added.

scale fuel cell system operating today is 78.96 MW of capacity in Seo-gu, Incheon, South Korea.[10] The CARB Technology Clearinghouse database of low- and zero-emission technologies[11] show where small-scale and large-scale electricity and combined heat and power (CHP) fuel cell systems are being used in California and across the U.S. for resilient primary and backup power.

Hydrogen fueled linear generators are fully dispatchable and fuel-flexible with the ability to deliver clean, firm power at low cost. Modular and scalable, linear generators can be deployed where the demand exists, either at a local level or at utility scale. Fast-ramping with 24/7 load-following capability, linear generator technology can instantaneously respond to load fluctuations as well as grid outages caused by wildfire, extreme weather events, or other unforeseen disruptions.

Long-duration energy storage coupled with hydrogen powered turbines will also be instrumental in providing clean, dispatchable power and bridging the anticipated capacity gap identified by the CARB. With current turbine technology capable of providing 450 MW of output per turbine, this technology will be necessary to account for the gigawatt level capacity deficiency while also minimizing the impact to ratepayers. In the absence of high-efficiency turbine technology, the grid will rely on less-efficient and higher-emitting plants to meet the demand requirement in various times of the year. Additionally, the implementation of hydrogen-capable turbine technology will prevent the deployment of stranded assets as California moves to a zero-carbon grid. This will not only provide emission reduction benefits but also long-term cost benefits due to the flexible fuel capabilities of the technology.

Hydrogen is uniquely positioned to cost-effectively provide zero-carbon firm dispatchable generation directly and through fuel cell systems, linear generators, and hydrogen powered turbines while accelerating cross-sectoral decarbonization. Thus, we recommend CARB includes an action plan to support the transition from fossil gas facilities to zero-carbon fuel.

Considering the changing role of the gas sector regarding the overall energy outlook, this is a timely decision. As noted in the Scoping Plan, the energy sector has changed profoundly in the last 20 years. Since the wake of the energy crisis, intermittent renewable capacity has grown tenfold, from 1,924 MW in 2002 to 19,977 MW in 2020.[12] This dramatic increase in intermittent renewable capacity suggests that a transition towards decarbonization might be easily attainable. Unfortunately, it has been paired with a significant rise in the amount of energy curtailed because renewable energy is often generated in periods of low demand. According to the California Independent System Operator (CAISO), California's wind and solar curtailments hit a record high of nearly 350,000 MWh in March 2021.[13] As seen in Figure 2, renewable and clean hydrogen can harness this abundant renewable resource for later use in the

[10] 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

[11] 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

[12] 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

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

power sector (even in a different season) and concurrently harness this abundant energy source to displace fossil fuels in other sectors.

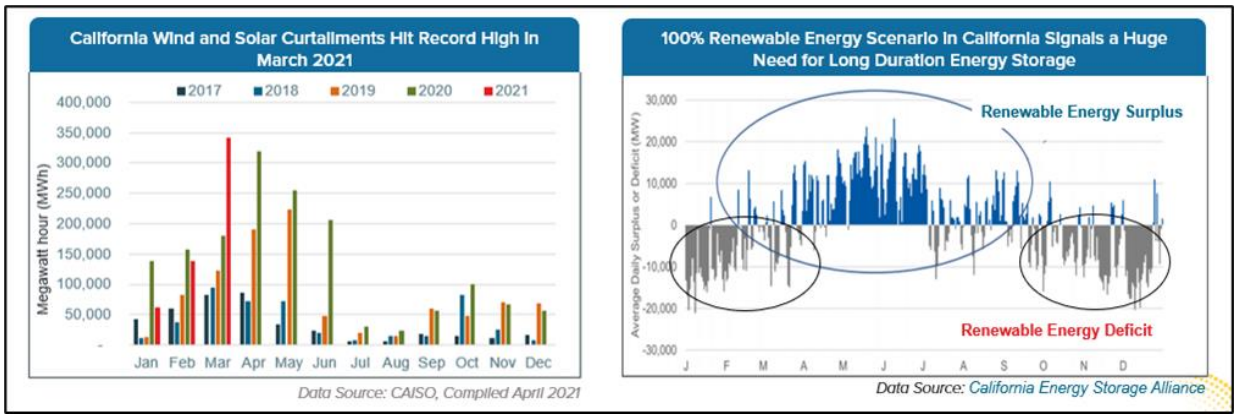
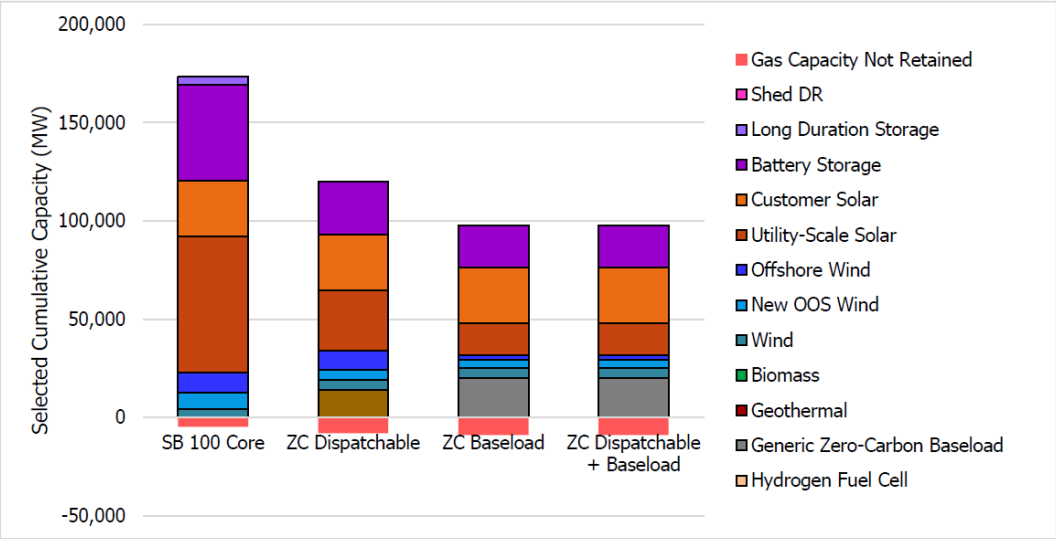


Figure 2 Substantial storage capacity will be needed to support a 100% renewables scenario in California

As noted in the Scoping Plan, California's most stringent climate goal is enshrined in SB 100, which requires the decarbonization of 100% of retail electricity sales by 2045. To better understand the investments, benefits, and costs related to SB 100, CARB and the CEC have already released the SB 100 Joint Agency Report (JAR), identifying a series of portfolios that may meet this target.

While the SB 100 Core scenario was selected as a type of benchmark for meeting SB 100 goals, the JAR also identifies other alternatives dependent on certain sensitivity factors. The SB 100 Core portfolio selected 145 GW of incremental utility-scale capacity additions by 2045, including 70 GW of solar PV, 4 GW of pumped storage, and 49 GW of battery storage.[14] This portfolio has an estimated total resource cost of 66 billion USD by 2045.[15] To better understand the benefits of zero-carbon firm capacity, this report also considered a generic Zero-Carbon Firm Resource scenario in which "generic dispatchable" resources and "generic baseload" candidate resources were included to represent a wide variety of emerging technologies, such as natural gas with 100% carbon capture, 100% clean hydrogen combustion, or other renewable fuels. In scenarios where either the generic dispatchable resource, generic baseload resource, or both are included as a candidate resource, the model selected about 15 GW of either or both resources in total. Including the lower-cost zero-carbon firm resources significantly lowers the utility-scale solar and battery storage selected in the model and reduces total resource cost in 2045 by $2 billion, or about 3 percent.[16] **These figures demonstrate that the cost of meeting our policy targets is directly contingent on California's investment in zero-carbon firm assets, such as renewable and clean hydrogen.**

[14] 2021 SB 100 JAR, at 75.
[15] Ibid, at 83.
[16] Ibid, at 13.



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[17]

Given the estimated need for zero-carbon firm dispatchable generation and its affordability benefits, CARB should prioritize transitioning critical gas infrastructure to clean hydrogen to meet future electric generation needs. Specifically, we submit that CARB should consider the needs of local load pockets, local reliability areas (LRAs), and hard-to-electrify customers and sectors to construct a cohesive landscape of the assets that merit continued investment to repurpose and timely switch them towards clean hydrogen.

Just as the 2021 SB 100 JAR, this Scoping Plan must acknowledge that thermal generation will provide reliability, resiliency, and resource adequacy in a future decarbonized California to support weather-dependent intermittent renewable resources and fluctuations in demand. Ultimately, the critical value of thermal generation will be to deliver the capacity backup needed to help ensure reliability during multi-day periods where renewable production is significantly lower than demand. Local, onsite hydrogen generation produced with renewable electricity can serve as a fuel and long-duration energy storage for thermal generation resources to produce local dispatchable resilient clean electricity. It can also address the opportunity to repurpose existing gas infrastructure while maintaining reliability. Once 100% hydrogen pipeline transport is possible, these thermal generating resources can be converted to 100% hydrogen in the long term.

For these reasons, we urge CARB to collaborate with gas utilities, industry stakeholders, academics, and policymakers to identify the facilities and assets that will continue to play a critical role in meeting California's reliability and resiliency needs. We are certain that just as the SB 100 JAR suggests, promoting green hydrogen today represents a least-cost, best-fit approach to ensuring reliability and achieving California's decarbonization goals.

[17] Ibid, at 13.

Public Safety Power Shutoffs

The Scoping Plan should account for frequent public safety power shutoffs that rely on backup diesel generators. 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.[18]

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.[19]

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.[20] 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 CARB's Scoping Plan, but the particulate matter of diesel generator use is neither accounted for or 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, CARB should take steps to eliminate 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 and local districts should take steps to include zero emission technologies like fuel cells 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.[21] In 2020, solar curtailments accounted for 94% of the total energy curtailed in CAISO. Renewable curtailment undermines California's policy supporting a zero-carbon electricity market but

[18] https://ww2.arb.ca.gov/our-work/programs/emergency-backup-generators/about

[19] 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

[20] Ibid

[21] https://www.eia.gov/todayinenergy/detail.php?id=49276#:~:text=In%202020%2C%20CAISO%20curtailed%201.5,total%20energy%20curtailed%20in%20CAISO

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."[22]

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.

Carbon Intensity Focus

In the Scoping Plan, CARB states that "green hydrogen" is not limited to only electrolytic hydrogen produced from renewables.[23] As a result, the Scoping Plan does not definitively define hydrogen but identifies the types of hydrogen that would be eligible in the Scoping Plan. We are concerned that the eligibility considerations set forth across multiple regulations and plans by different regulatory bodies in California create uncertainty for investments in decarbonizing hydrogen are unclear. Failing to adopt uniform statewide definitions or a standard could stifle the growth of the hydrogen market in California and may impede California's ability to work toward decarbonization with neighboring states interconnected to California's electric grid and natural gas system. For this reason, we urge CARB to base hydrogen eligibility on a carbon intensity (CI) framework using a well-to-gate life cycle assessment (well-to-gate LCA)[24] rather than adopting the criteria outlined in the Scoping Plan. Adopting a CI framework using a well-to-gate LCA is a technology-agnostic approach, as it only considers the lifecycle emissions based on onsite and upstream production emissions. As a result, the door is open for competition to flourish so long as the hydrogen in question can meet the desired lifecycle emissions threshold. A CI framework also recognizes that hydrogen production technologies that are in the lab, demonstration, or pre-commercial phase (artificial photosynthesis, etc.) could emerge that complement or supersede current technologies.

Defining eligible hydrogen based on CI framework is already taking shape in, but is not limited to, British Columbia,[25] the European Union,[26] and the United States. For example, the recent United States

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

[23] See scoping plan p. i.

[24] 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

[25] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternativeenergy/electricity/bc-hydro-review/bc_hydrogen_strategy_final.pdf

[26] https://www.insideenergyandenvironment.com/2021/04/the-european-commission-approves-the-eucriteria-on-sustainable-hydrogen-activities/

Infrastructure Investment and Jobs Act (Infrastructure Bill) defines qualified "clean hydrogen" as "hydrogen produced with a CI equal to or less than 2 kilograms of CO_2e per kilogram of hydrogen." This bill also 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. This standard will create a rigorous framework for evaluating the lifecycle emissions of hydrogen production pathways and robust measurement and verification, and reporting structures. The purpose of the standard is to create a uniform national framework to increase the cleanest hydrogen development and deployment.[27]

Another CI framework example is CARB's LCFS. The LCFS sets an annual CI standard to reduce the CI of the transportation fuel used in California by at least 20 percent by 2030. The LCFS lets the market determine which mix of hydrogen will be used to reach the program targets and does not preclude production pathways or feedstocks if it is equal to or lower than the carbon threshold. The LCFS has proven to be one of the essential AB 32 measures to reduce greenhouse gas emissions in California and has provided other significant benefits – it transforms and diversifies the fuel pool in California to reduce petroleum dependency and achieves air quality benefits, which are State priorities that preceded AB 32.

CARB has a unique opportunity to take a similar approach and adopt its own CI framework using a well-to-gate LCA for hydrogen specifically for this Scoping Plan. CARB can use the above examples to inform best practices and lessons learned and develop a CI framework particular to California's needs. Developing and adopting such a framework would explicitly allow CARB to exclude the use of fossil resources and allow for the possibility for technological innovation to flourish, enabling new pathways to produce hydrogen to be considered, so long as they have climate integrity (e.g., emits zero or de minimis[28] amounts of greenhouse gases on a well-to-gate life cycle basis). Encouraging such innovation will, by definition, increase competition, and foster greater private hydrogen investment for the benefit of California ratepayers.

Overall, we submit that CARB not adopting a definition carries a risk to hydrogen investments that may complicate decarbonizing California's economy. To that end, we support developing a hydrogen a CI framework on a well-to-gate LCA to define hydrogen eligibility beyond transportation fuels.

Pipelines Enable Scale

CARB, in consultation with other state agencies, should provide a strategic vision 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 gas pipeline 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.

[27] United States' Infrastructure Investment and Jobs Act. Sec. 822.

[28] "De minimis" means an insignificant amount of non-renewable energy resources (does not exceed 10 percent of the total energy inputs) allowed to be counted as RPS-eligible. See Green, Lynette, Christina Crume. 2017. Renewables Portfolio Standard Eligibility Guidebook, Ninth Edition. California Energy Commission, Publication Number: CEC-300-2016-006-ED9-CMFREV.

In future years, a 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 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.

Agriculture Sector

CARB's Scoping Plan fails to capture the full GHG emissions impacts from the agriculture sector. The scoping plan only focuses on the GHG impacts from agricultural energy use within the state's borders and does not consider the carbon emissions embedded in the ammonia used to produce the fertilizer for California crops. Ammonia (NH3) is already a globally traded commodity -- approximately 80% of global production is used for fertilizer production. It is produced from gray hydrogen (hydrogen produced from fossil fuels) and atmospheric nitrogen. California does not produce ammonia in the state, rather it imports ammonia made from fossil fuels and transports them here by rail or by ship into the Port of Stockton. Ammonia production in North America produces 2.129 tons of carbon dioxide per ton of ammonia produced.[29]

For perspective, California's import of 0.75 billion kg of ammonia in 2018 was responsible for approximately 1.6 billion kg of CO_2 emissions, which is underestimated because it does not take into account the shipping or rail transport emissions created importing this large quantity of ammonia into California.[30] As a result of the omission of the embedded emissions in ammonia imports, the scoping plan considers the agricultural sector as one of the lowest GHG emitting sectors, when clearly, it is a significant contributor. If these emissions were considered in the Scoping Plan, the agricultural sector would have had much higher GHG contributions.

Further, the Scoping Plan, in calling for 25% of energy demand to be electrified by 2030 and 75% by 2045, pre-supposes that electrification is the only solution. To be clear, we support electrification – however, we recommend that the goals for the agricultural sector be set based on achieving specific

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

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

decarbonization goals without presupposing the solution. As noted earlier, the most significant driver of decarbonizing agriculture will be driven by moving from fossil fuel-derived ammonia to renewable or green ammonia. Other energy uses in the agricultural sector may be well served through electrification and as is the case in other sectors, some end uses may not be easily electrified – for those uses, renewable fuels including green hydrogen and its derivative fuels should explicitly be allowed to compete.

The good news is that with the increasing scale of green hydrogen production, the prospect of cost-competitive green ammonia is now within sight. The war in Ukraine has driven up fossil fuels costs not only to extraordinary levels in Europe but also here in North America. Natural gas prices have risen quite substantially and so have ammonia prices, which are closely pegged to natural gas prices given that hydrogen produced from natural gas is a significant component of ammonia production cost. Anhydrous ammonia pricing has since risen to all-time highs -- it is now ~$1400/ton in Europe and in ~$900/ton in CA, whereas it normally trades at below $500/ton.[31]

Producing green ammonia from green hydrogen is now being developed at scale all over the world. As an example, below is an overview of announced green hydrogen to green ammonia production projects funded by Copenhagen Infrastructure Partners, a global fund management company specializing in energy infrastructure investment. [32]

Project Name/Location	GH2 capacity and source	Green Ammonia production & offtake	Construction Complete
Host (Denmark)	1GW electrolysis Offshore wind, solar, Grid	200-300 kilo tons/yr - fertilizer	2023
Iverson (Norway)	240 MW electrolysis Wind and solar	600 metric tons/day – ammonia as a global commodity	2024
Murchison Renewable Hydrogen Project (Australia)	3 GW electrolysis Wind and solar	1.7 million tons/year – export to Asia for power production	2030
HNH Energy (Chile)	5 GW electrolysis Wind energy	TBD – fertilizer and shipping fuel supply	2029
Madoqua Project (Portugal)	400 MW Grid-connected, onshore wind, and PV	TBD – chemicals and fertilizer, potential shipping fuels	2026

Given these recent global trends, the timing for developing locally produced renewable alternatives to fossil-based ammonia production has never been better. This will enable California's farmers to decarbonize their crops, enhance yield, and decouple fertilizer cost and availability from the volatility associated with fossil fuels. This will help California to:

a. Increase energy and food security

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

[32] Source: Copenhagen Infrastructure Partners interviews and website

b. Diversify California's central valley economy, reduce outflows of capital from California to Texas and gray ammonia producers in the Gulf of Mexico
c. Repurpose some portion of agricultural land to less water-intensive high, value renewable energy & green hydrogen production
d. Leverage future demand for green hydrogen and green ammonia production to justify new municipal water infrastructure projects, increasing water security for consumers (e.g., Municipal water recycling and storage projects)
e. Position California to supply green ammonia as a carbon-free alternative to diesel and bunker fuel for maritime shipping
f. Position California as a national leader for green hydrogen and green ammonia production, with large domestic uses (green ammonia, shipping fuel) and to position California for unlimited export potential. For example, in early 2022, JERA, Japan's largest Independent Power Producer, in an effort to achieve zero CO_2 emissions from its domestic and international businesses by 2050, launched a project to demonstrate the use of ammonia as a fuel for power generation and concurrently issued a global RFP to import 500,000 tons of decarbonized ammonia to Japan[33]
g. Rapidly scale green hydrogen production to support immediate demand for green fertilizer, a concentrated and high-volume application of green hydrogen.
h. Create many highly skilled, high-paying jobs in some of the most disadvantaged areas of the state. The fertilizer industry contributes about $8.6 billion to the California economy and $632 million in state taxes. The California fertilizer industry already employs a significant workforce. This includes about 3,451 jobs in retail and 933 in distributors.[34]
i. These figures would increase with investment in green ammonia.[35]

CARB, in its Scoping Plan can provide the needed leadership for realizing this foundational opportunity for deeply decarbonizing California's agricultural economy. The starting point requires appropriate tracking of all emissions resulting from our agricultural sector, including embedded emissions in the fertilizer we import. Additionally, through program development, CARB can provide the needed leadership and guidance to ecosystem stakeholders to help drive demand for decarbonized alternatives.

With green hydrogen being touted as the next commodity to revolutionize the energy market, it is very important to plan for and realize the significant benefits to California from fully including deep decarbonization of the agricultural industry in this Scoping Plan.

Embrace the "Earthshot"

[33] https://www.jera.co.jp/english/information/20220218_853
[34] 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].
[35] 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].

On June 7, 2021, Secretary Granholm announced the federal government's Hydrogen Energy "Earthshot" initiative to reduce the costs of clean hydrogen to $1 per kilogram in a decade.[36] This ambitious pricing target reflects the importance of hydrogen as an energy carrier in decarbonization, but also recognizes that California's climate allies in Asia and Europe are much further ahead in planning and execution of the deployment of hydrogen in their carbon reduction strategies. Achieving $1 per kilogram of clean hydrogen far exceeds the cost reductions needed to directly compete with existing fossil fuel resources and in California makes hydrogen more cost-effective than retail electricity.

The DOE's Hydrogen Energy Earthshot initiative is a wakeup call to the country and a market signal to industry; California must similarly send market signals and create a predictable policy environment to encourage investment. The world often looks to California not only for leadership but also partnership when it comes to decarbonized energy and mobility. Our climate partners are leading the way and it is time for California to embrace our leadership role in this space. The hydrogen economy will not be built by one jurisdiction alone. We can partner in the development of a zero-carbon and domestic energy resource that, when paired with zero-carbon end uses, can displace 1:1 fossil fuel without an expectation of mass behavioral change from the public and while providing a just transition for thousands of businesses and hundreds of thousands of Californians.

More than thirty-five countries have now recognized there is a large role for hydrogen in achieving national strategies for climate change emissions reductions and in attempts to achieve carbon neutrality have released comprehensive hydrogen strategies. The hydrogen industry is investing billions into the establishment of a hydrogen economy that will help adoption of hydrogen as an energy carrier. The Hydrogen Council has noted in July 2021 that, globally, 359 large-scale hydrogen projects had been announced to date. The total investment into projects and along the whole value chain amounted to an estimated $500 billion through 2030, and more investments have been announced since then. However, there is more work to be done and the Scoping Plan presents some immediate opportunities to send investable signals to the private market and drive capital toward the appropriate investments for California's future.

Hydrogen Hubs and the 2022 Budget

The 2022-2023 budget surplus allows California to allocate matching dollars toward the federal and private funding contributions made in support of a hydrogen hub in California. Given the large demand of hydrogen fuel called for in energy, industry, heavy-duty transportation, aviation, rail and marine, among others, investments made for commercially available cars and trucks today will launch the hydrogen ecosystem necessary to provide a cost-competitive, clean, and reliable fuel of the future. We encourage CARB to support the efforts of the Governor's Office of Economic Development in creating a dynamic proposal that will serve multiple production pathways and diverse end uses to help California win some of these federal funds and leverage private capital to fully launch California's hydrogen economy.

Conclusion

[36] Department of Energy Hydrogen Energy Earthshot Initiative, June 21, 2021. Available at: https://www.energy.gov/eere/fuelcells/hydrogen-shot

We urge CARB to consider our comments and potential environmental and economic benefits of elevating hydrogen's role in the next draft of the Scoping Plan. 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 throughout the economy will have significant environmental, health, equity, and economic benefits for all Californians.

On behalf of the undersigned hydrogen partners, we thank you and we look forward to discussing further. If you have any questions please contact Teresa Cooke, Mikhael Skvarla, Katrina Fritz, Sara Fitzsimon, Janice Lin, and Nicholas Connell.

Sincerely,

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