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Rajinder Sahota, Deputy Executive Officer for
Climate Change & Research
California Air Resources Board 1001 I Street
Sacramento, CA 95814

Comments submitted electronically

RE: Comments Related to the 2022 AB-32 Scoping Plan Update August 17, 2021 Scenario Concepts Technical Workshop

Dear Ms. Sahota,

Air Products is pleased to provide comments in support of CARB's 2022 update of the AB 32 Scoping Plan. We support CARB's climate goals and believe that Air Products can help California with the energy transition needed to meet these challenges.

Air Products is the only US based global industrial gas company, in operation for over 80 years with operations in more than 50 countries around the globe. The company's core industrial gases business provides atmospheric and process gases and related equipment to manufacturing markets, including refining and petrochemical, metals, electronics, food and beverage and healthcare. Approximately 19,000 employees globally work to make Air Products the world's safest and best performing industrial gases company, providing sustainable offerings and excellent service to all customers.

Worldwide, Air Products is the largest hydrogen producer with over 8,000 metric tons per day of production capacity and over 1,800 miles of industrial gas pipelines. Within California, the company safely operates 9 hydrogen production facilities, 35 miles of hydrogen pipeline and currently supplies a network of light-duty and heavy-duty transit bus hydrogen fueling stations, facilitating the transition to carbon-free transportation. In fact, Air Products supplies ~80% of the hydrogen currently used in the California mobility market.

Air Products is committed to meeting the world's carbon reduction and energy transition challenges at scale. As an example, we have announced the world's largest green hydrogen project in Saudi Arabia. This $5 billion project will deploy nearly five times more electrolyzer capacity than had been installed globally at the time the project was announced. Our company has committed an additional $2 billion to develop the distribution and refueling infrastructure to bring this fuel to mobility markets around the world. We have also announced a net-zero carbon blue hydrogen project – a $1 billion investment in a hydrogen energy complex in Alberta, Canada, which deploys carbon capture and sequestration (CCS) coupled with an innovative design and advanced technology to minimize emissions of both greenhouse gases and criteria air pollutants. Air Products' hydrogen supply and distribution capabilities stand ready to contribute to California's achievement of its carbon reduction goals.

As CARB acknowledges in their presentation on slide 10, hydrogen is one of the 5 identified energy alternatives as the state transitions away from the fossil fuels. Air Products believes that hydrogen is the most viable energy source that can decarbonize a significant portion of the economy; especially the hard-to-abate emissions sectors such as heavy-duty transportation, shipping, aviation, chemicals, cement, power, and metals (steel, aluminum, and iron) production. When used as a fuel or energy carrier in these sectors, it produces very low or no direct emissions improving local air quality in contrast to some of the other fuels mentioned by CARB on this slide. In a complement to renewable electricity, hydrogen also provides important grid reliability, resilience and energy storage as renewable generation grows.

California is a recognized global leader in setting policies to reduce carbon. With strong policies combined with its large market, California can incent the kind of global scale projects that are needed to achieve cost-effective scale for low and zero-carbon hydrogen. As part of a global decarbonized hydrogen market, California can support projects in and around the state's ports and in all applications where hydrogen is used. **All scenarios CARB considers for the scoping plan update should provide for this future and include hydrogen as a zero-emission fuel and clean energy resource.**

Specific Scenario Comments

Following the format of the workshop presentation, Air Products offers the following feedback on select scenario proposals (with slide references from CARB presentation):

Carbon Neutrality Timeframe (slide 12):

We believe that CARB needs to carefully consider both air quality and climate goals and balance what reductions can be achieved today while technologies improve or evolve, and new clean energy production and infrastructure is commercialized. For example, hydrogen produced today using conventional steam methane reforming technology and natural gas provides over a 30% improvement in carbon intensity when compared to conventional transportation fuels[1] and zero criteria and toxic vehicle exhaust emissions – bringing much needed air quality and health benefits to disadvantaged communities. The carbon intensity of hydrogen can be lowered using renewable natural gas and will only improve over the time horizon covered by this scoping plan update as technologies like CCS and electrolysis from renewables are deployed.

To the extent that the state accelerates the transition to decarbonized energy, Air Products supports regulatory framework improvements and additional investment in large-scale low or zero carbon hydrogen production hubs. Direct investment aligned with energy demand centers is necessary to rapidly deploy decarbonized production sources to effectuate rapid decarbonization in the hard-to-abate industrial and transportation sectors. Sources of production encourage the development of

[1] Union of Concerned Scientist "How Clean Are Hydrogen Fuel Cell Electric Vehicles" Fact Sheet (September 2014)

end use technology and provide the supply reliability necessary to encourage the transition to new sources of energy. Regulatory framework improvements like streamlined permitting, heavy-duty hydrogen refueling infrastructure low carbon fuel standard credits, and enabling low carbon hydrogen attribute tracking/crediting will further accelerate these hydrogen hubs and associated market development.

Scenarios and policies that encourage additional hydrogen production, infrastructure, and use today provide both near-term emission reductions and enable a faster transition to even lower carbon hydrogen energy in the future. The scoping plan scenarios should explore the role of hydrogen hubs to facilitate this transition.

The Role of Engineered Carbon Removal (slides 13 & 14):

CARB should resist the concept that CCS should not be deployed in all applications where it can effectively and economically reduce carbon emissions. All carbon emission mitigation, including removal, is going to be needed to meet CARB's climate goals.

It's important to note that CCS can contribute to overall greenhouse gas reductions and air pollution reductions. CCS has been clearly demonstrated and supported by globally respected scientific research over many years. Indeed, California's Lawrence Livermore National Lab (LLNL) has been a strong proponent of CCS and demonstrates that support at workshops based on their report *Getting to Neutral*.[2] Strategies to capture CCS will also deliver additional criteria air pollutant reductions, which may vary based on technology and application, but are directionally consistent and deserve further analysis.

We encourage CARB to fully explore the air pollution co-benefits associated with CCS in its Scoping Plan and associated air quality modeling, and to avoid assuming that stationary sources of combustion are incompatible with the state's environmental goals. A hydrogen power plant or production facility with CCS may have zero or de minimis levels of toxic air contaminant and particulate matter emissions, and significantly lower NOx emissions. CCS and hydrogen used in stationary sources can deliver significant criteria and GHG reductions to help CARB meet its climate and air quality goals. In fact, hydrogen produced using biomass coupled with CCS is the only hydrogen production technology that can produce negative carbon emissions. Additional analysis will help elucidate these benefits further.

Specifically, for hydrogen, deployment of CCS can substantially reduce the carbon intensity of hydrogen regardless of whether the hydrogen is used to improve the carbon emissions profile of conventional fuels, renewable fuels, or as a direct substitute for those fuels in transportation or heavy industry sectors. It can also deliver significant, near-term GHG reductions without further straining the grid or competing with renewable power development needed to meet SB 100 goals.

California is already facing a significant electricity capacity shortage through at least 2026, and the energy agencies' SB 100 report suggests that "record-breaking" renewable energy development is

[2] https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf

needed over the next 25 years to meet SB 100 goals. What's more, in a 1.5°C climate scenario, Bloomberg New Energy Finance estimates that more electricity would be needed just to power electrolyzers than is currently produced in the world, and that many regions would lack sufficient land for the renewable power required, necessitating a global trade of green hydrogen.[3] If we require or expect hydrogen to be produced from renewable electricity in the near-term, or expect it to be produced in-state or even in the western United States, we will only be competing with the resources needed to maintain grid reliability now and meet our SB 100 goals, while limiting our opportunities to decarbonize our economy now – both in California and globally.

In contrast, hydrogen production with CCS can satisfy the near-term carbon reduction and air quality improvement goals while hydrogen demand and renewable energy supply can grow in parallel. Deployment of hydrogen produced using CCS concurrently with development of decarbonized electrolytic hydrogen will accelerate carbon reductions in multiple sectors sooner than if either technology were exclusively favored. **The scenarios CARB evaluates in the Scoping Plan Update must include CCS as an important tool for reducing carbon emissions and resist limiting its role to only certain sectors.**

Carbon Free Electricity Grid (slides 15 & 16)

Hydrogen and CCS can play important roles in reducing emissions from firm and dispatchable power plants needed to balance the grid. Hydrogen can both replace fossil natural gas in direct power generation and provide longer-duration, multi-day and seasonal energy storage as more renewable resources are placed on the grid. Both roles improve grid reliability which makes hydrogen and CCS essential energy resources for the state's electrical grid.

In the SB 100 report modeling[4], virtually all natural gas power plants are kept online through 2045 and beyond to provide grid reliability. The result, according to the analysis, is 24 $MMTCO_2$ emissions in the power sector in 2045 and beyond, even in an SB 100-compliant scenario. These power plants can be decarbonized, too, however, and we encourage CARB's scenarios to consider the role the hydrogen and CCS can play in more quickly and deeply decarbonizing the electricity sector, while ensuring grid reliability is maintained. Providing firm, zero carbon power with decarbonized hydrogen and CCS will help to avoid overbuild of under-utilized grid resources. The SB 100 report clearly identifies the significant cost and emissions benefits associated with firm, zero carbon resources, which hydrogen produced with CCS can clearly provide.

CARB's scenarios for a carbon free electricity grid should include all available technologies including use of hydrogen and CCS to decarbonize existing power plants and maintain grid reliability with lower emissions.

[3] https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf

[4] 2021 SB 100 Joint Agency Report

Vehicle Fleet Electrification (slides 19 & 20)

Air Products fully supports Governor Newsom's Zero Emission Vehicle (ZEV) Executive Order N-79-20 requiring the transition of all light, medium and heavy-duty vehicles in the state to zero emission technologies, which include both battery electric (BEV) and hydrogen fuel cell electric vehicles (FCEV). The decarbonization of the transportation sector needs bold, concrete timelines to make this important switch as the reduction of emissions from conventional vehicles has been limited by ever increasing vehicle miles traveled.

However, regulations requiring the production and sale of all classes of ZEVs are only part of the equation. If ARB is to model accelerated ZEV scenarios, it is important to make sure policies are in place to support deployment on an accelerated scale, including appropriate incentives and infrastructure. With respect to hydrogen FCEVs, that refueling infrastructure must include dedicated hydrogen fuel production for the transportation market as well as hydrogen refueling station coverage and capacity.

It would be informative to analyze scenarios where the state proposes to achieve accelerated carbon neutrality by 2035 in addition to the statutory goal of carbon neutrality by 2045. **Air Products is supportive of the modeling scenario options proposed by CARB.**

Lastly, hydrogen offers a promising solution for decarbonizing shipping, commercial aviation, and rail. In some cases, especially for shipping, zero-carbon ammonia (NH_3) offers a promising solution. Many shipping companies are already looking to convert to ammonia to reduce both climate and criteria emissions impacts from their operations. Decarbonizing ammonia supply chains will also help decarbonize fertilizer and agriculture. **CARB should consider these applications for zero carbon hydrogen and the role ammonia may play in the shipping or other applicable sectors in its scenarios for the Scoping Plan.**

Woody Biomass and Solid Biomass Waste (slides 25 & 26)

To meet the State's goals, CARB needs to include all carbon sources and potential options to control or convert these sources to clean energy. Wildfires and agricultural burning contribute substantial carbon emissions and degrade air quality. Mitigating these sources needs to be part of the solution.

In the report *Getting to Neutral, LLNL suggests* that "*converting this biomass into fuels with simultaneous capture of the process CO2 emissions holds the greatest potential for negative emissions in the State".* The report further emphasizes that "*Gasifying biomass to make hydrogen fuel and CO2 has the largest promise for CO2 removal at the lowest cost and aligns with the State's goals on renewable hydrogen."* Air Products agrees with this assessment and sees promise in the role of gasification to produce hydrogen from biomass – not only creating negative carbon hydrogen as a clean energy source, but simultaneously mitigating wildfire risk and related air quality impacts. **The scoping plan scenarios should include an analysis of converting this biomass to carbon negative hydrogen for use in the energy transition and should include California-specific assessments of biomass potential and the waste biomass resource to be managed.**

Residential and Commercial Building Decarbonization (slides 27 & 28)

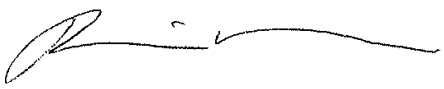
While not expressly addressed on the slides, any scenarios that CARB contemplates involving blending of hydrogen into natural gas for residential and commercial use needs to recognize that limitations to this blending exist in terms of pipeline materials, component materials and function (i.e., meters) and impacts on end user equipment and appliances (different flame patterns, flame temperature with associated NOx increases, heat transfer requirements, etc.). Additionally, because of the lower energy density of hydrogen, more volume is needed which may create constraints in the system that require expensive retrofit. As the world's largest and most experienced operator of hydrogen pipelines, we encourage the state to support a competitive marketplace for hydrogen production and delivery, and not assume that the use or conversion of the existing natural gas pipeline network is necessarily the most effective way to deliver zero-carbon hydrogen at scale. Safety, pipeline integrity and impacts to end-users of blending must be understood. **Any assumption of hydrogen blending into existing natural gas systems into these scenarios needs to be fully evaluated to ensure public safety.**

Industry (Manufacturing, Construction, and Agriculture) (slides 29 & 30)

Low carbon hydrogen should absolutely play a role in decarbonizing those industries that require very high heat, for which electrification would be prohibitively expensive (e.g., cement, steel, glass, tile) and that currently use natural gas as their fuel. In these sectors – many of which operate on a continuous basis, it is critical to have high heat and to have it reliably delivered on a constant basis. Intermittency of renewable electricity combined with battery back-up would not provide a sufficient reliable energy resource on which those industries could rely. Option A on slide 30, with the stark choice between electrification or shutting down, is untenable and will lead to cost ineffectiveness and emissions leakage. While technologies will certainly develop over time, mass electrification for these industries is not currently feasible. **We encourage CARB to include a substantial role for CCS and low carbon hydrogen initially with a transition to decarbonized hydrogen in the scoping plan scenarios for these heavy industrial sectors.**

Air Products appreciates the opportunity to provide this feedback and would be happy to meet with CARB to provide additional details related to scenario development. Please feel free to contact me by phone (916-860-9378) or email hellermt@airproducts.com.

Respectfully,



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