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ZeroAvia Comments on the Onsite Distributed Hydrogen Production and End Use Solicitation Concept 22-ERDD-03

Additional submitted attachment is included below.

California Energy Commission
715 P Street
Sacramento, CA 95814
1000 Independence Avenue, SW

Attn: Distributed Hydrogen Solicitation Concept 22-ERDD-03

Re: ZeroAvia Comments on the Distributed Hydrogen Solicitation Concept 22-ERDD-03

ZeroAvia appreciates the opportunity to provide comments on the California Energy Commission (CEC) Distributed Hydrogen Solicitation Concept 22-ERDD-03.

ZeroAvia's mission is to succeed in decarbonizing the hard-to-abate aviation sector through hydrogen-electric propulsion. Our goal is to challenge, change and accelerate the transition toward a sustainable aviation future. ZeroAvia's aviation solution is focused on on-board liquid hydrogen storage, coupled with a fuel cell system using Proton Exchange Membrane (PEM) technology. This system does not burn or combust hydrogen, but instead combines hydrogen with oxygen from the air to generate electricity. The electricity then spins an electric motor for propulsion—either via turboprop (propeller) or turbofan (jet). This solution is not only the most impactful from a climate perspective (>95% climate impact reduction vs <60% for Sustainable Aviation Fuels), but also incurs lower maintenance expenditures than a combustion engine burning conventional jet fuel.

ZeroAvia is already working with the CEC on a separate grant opportunity for which we were awarded earlier this year (GFO-22-502 - Innovative Hydrogen Refueling Solutions for Heavy Transport) to advance our liquid hydrogen refueler for aircraft applications. As CEC considers improvements to the future solicitation (to which ZeroAvia intends to apply), we would like to address the following questions where feedback was solicited:

1. Are the Project Elements in Section IV of this document realistic, reasonable, and feasible?

We do not believe the following Project Element to be realistic, reasonable, or feasible: *"Minimize water consumption where possible and limit water consumption to 9-13.5 kilograms of water per kilogram of hydrogen produced. Water for projects must not be originally intended for human consumption."* Per chemistry fundamentals, 9 kilogram (kg) of water are required to produce 1 kg of hydrogen via electrolysis. When layering in the additional volume required for water purification and process cooling, an additional ~10-20 kg_{H2O}/kg_{H2} is needed. Inefficient designs such as evaporative cooling systems may exceed this range, but those systems are uncommon, especially at large scales of production. Even factoring in this additional volume, clean hydrogen's cumulative 20-30 kg_{H2O}/kg_{H2} of water consumption is on par with or even less than the 20 to 40 kg_{H2O}/kg_{H2} of water required for fossil-based hydrogen production pathways.[1] Additionally, the constraint to limit this to solely waste sources of water is extremely restrictive. Sources that fit this criterion, such as leachate from landfills or seawater, are very costly to purify to the specification required for electrolysis. This criterion presents significant logistical challenges if one would like to, for example, site electrolysis at or near an airport.

[1] https://rmi.org/hydrogen-reality-check-distilling-green-hydrogens-water-consumption/

2. What would be the appropriate level of project funding that would leverage private investments associated with the work proposed in this draft concept, and why?

a. How would limiting the use of grant funds to Eligible Project Costs in Section III impact the project? What changes do you recommend if any, and why?

We believe the proposed level of project funding is appropriate, along with the Eligible Project Costs. We would recommend lowering the required cost-share threshold to 25% to enable competitive access to earlier-stage companies, and not bias the submission toward large-balance sheet companies (e.g., Oil & Gas industry).

3. Provide any feedback on the two-phase solicitation approach. Are the 1-month abstract deadline and 3-month full application deadline realistic?

We believe the 1-month abstract deadline is appropriate, as long as scope flexibility between abstract and full application submission is permitted. The 3-month Full Application is challenging considering the level-of-detail required, and, again, we believe this biases the competitive submission towards companies with greater resources. We would recommend a minimum 4-months for the Full Application submission – this would also result in a higher-quality of applications and a more robust pool of applicants.

4. To ensure that funded projects and their impacts can inform future deployment of hydrogen in California, should the CEC consider additional performance metrics beyond those proposed for the M&V plan in Section IV?

We have the following questions/concerns on the M&V plan as articulated in Section IV:

- **How does CEC intend to measure customer costs?**
- **How are air pollutants to be measured – where and how?**
- **What are the system performance parameters of interest?**
- **How will leakage be measured for hydrogen?**
- **What are system payback methodologies and requirements?**

5. What type of technical assistance is needed to ensure equitable participation and project success, if any?

ZeroAvia does not have any comments on this item.

6. Are there specific end uses we should target with the one to five metric ton hydrogen capacity? If so, why?

Our desire is to apply to this solicitation with the idea of on-site airport production of hydrogen for the intended end-use in aircraft. Our primary target is hydrogen-powered aviation, while we actively collaborate with potential customers in heavy ground transportation and maritime. According to several reports[2] by government and

[2] https://pphs.usc.edu/airport-pollution-linked-to-acute-health-effects-among-people-with-asthma-in-los-angeles/

academia, airport operations result in noise and air pollution, which are linked to many of the negative health and quality of life outcomes experienced by airport communities. Most people living within 10 miles of airports in several major metropolitan areas across the United States and in California identify as African American, Hispanic/Latino, or Native Hawaiian/Pacific Islander. People living within 10 miles of airports face significant disparities in health, resources, and risk factors compared to the general population. Aviation is now the single largest source of airborne lead emissions[3] in the US despite lead having a proven detrimental impact on children brain development and nervous systems. The presence of this fuel means the areas near these airports are often inundated with tiny lead particles[4]. Disadvantaged and low-income communities are disproportionately represented in these airport-proximate locations. Fuel cell-based hydrogen powered electric powertrains eliminate all lead, PM2.5, NOx, CO, CO_2 and SOx emissions along with a significant reduction in engine noise when compared to traditional kerosene engines. Including aviation as a specific end-use advances California's goals around energy-equity and environmental justice.

7. Are there any concerns with this solicitation allowing the use of CCUS for a project to be carbon neutral? If so, why?

Our perspective is that the solicitation should not permit the use of CCUS for a project to be carbon neutral. Allowing CCUS would essentially allow the use of "blue" hydrogen – hydrogen produced via natural gas reforming with carbon capture. The issue with this is that blue hydrogen producers and vendors are currently not adequately accounting for upstream methane leakage in their net GHG calculation. Research from academia within California highlighted that upstream methane leakage could be as high as 9%, which would result in a blue hydrogen that has a very high carbon intensity – this would not be conducive to the goals of this solicitation.[5]

8. Please provide relevant comments regarding other considerations not explicitly listed above.

ZeroAvia does not have any comments on this item.

[3] https://www.nbcnews.com/business/business-news/leaded-gas-was-phased-out-25-years-ago-why-are-n1264970, EPA source.
[4] Link to Feb 2020 source, EPA report: 'Model-extrapolated Estimates of Airborne Lead Concentrations at US Airports'
[5] https://news.stanford.edu/2022/03/24/methane-leaks-much-worse-estimates-fix-available/