DOCKETED	
Docket Number:	20-EPIC-01
Project Title:	Development of the California Energy Commission Electric Program Investment Charge Investment Plans 2021-2025
TN #:	238920
Document Title:	Lawrence Berkeley National Laboratory Comments - on Hydrogen Roadmap workshop comments
Description:	N/A
Filer:	System
Organization:	Lawrence Berkeley National Laboratory
Submitter Role:	Public Agency
Submission Date:	7/15/2021 4:48:33 PM
Docketed Date:	7/15/2021

Comment Received From: Lawrence Berkeley National Laboratory
Submitted On: 7/15/2021
Docket Number: 20-EPIC-01

Berkeley Lab - Hydrogen Roadmap workshop comments

Attached.

Thank you!

Additional submitted attachment is included below.

BERKELEY LAB
Bringing Science Solutions to the World

July 15, 2021

Chair David Hochschild
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

RE: Lawrence Berkeley National Laboratory Recommendations for the Development of the EPIC 4 Investment Plan - Hydrogen Roadmap and Strategic Plan for a Decarbonized California

Dear Chair Hochschild,

As part of its workshop series on EPIC 4 investment priorities, the Commission examined on July 1 the technology advancements needed to scale the production and use of hydrogen produced from renewable energy sources and develop a Hydrogen Roadmap and Strategic Plan for the state. Lawrence Berkeley National Laboratory appreciates the Commission's prioritization of hydrogen and agrees that hydrogen can support the cost-effective implementation of SB 100 by integrating more intermittent renewables, providing flexible supply to balance the grid and serving as carbon-free seasonal storage. Berkeley Lab appreciates the opportunity to submit comments aimed at assisting the state's development of green hydrogen technologies.

Berkeley Lab is one of several Department of Energy national laboratories leading the nation's development of hydrogen technologies. Current initiatives include two new consortia and a third continuing one to advance this clean energy technology, improving the durability, lifetime, and efficiency of fuel cells:

- Million Mile Fuel Cell Truck Consortium (M2FCT) – $50 million over five years, co-led by Berkeley Lab and Los Alamos National Laboratory. M2FCT focuses on enabling widespread commercialization of fuel cells for heavy-duty transportation, with a 2030 goal of systems that have a 25,000-hour lifetime, or 1 million miles for long-haul trucks,

- HydroGEN 2.0: Advanced Water Splitting Materials – $12 million over three years, led by the National Renewable Energy Laboratory (NREL), with Berkeley Lab and Sandia National Laboratories as co-deputies. This initiative aims to accelerate materials discovery for advanced water-splitting technologies for clean, sustainable hydrogen production. Berkeley Lab's main focus is on photoelectrochemical (PEC) water splitting.

- H2NEW: Electrolyzers – $50 million over five years, co-led by NREL and Idaho National Laboratory, with Berkeley Lab as co-deputy. This initiative focuses on development of affordable, reliable, and efficient electrolyzers. Large-scale production of hydrogen by electrochemically splitting water into hydrogen and oxygen will require affordable, reliable and efficient electrolyzers. Berkeley Lab will lead work on low-temperature electrolysis.

Berkeley Lab submits the following recommendations for the Commission's consideration.

Hydrogen Use and Production

On June 7, Secretary Jennifer Granholm announced the first Energy Earthshot—Hydrogen Shot—which seeks to reduce the cost of clean hydrogen by 80% to $1 per kilogram in one decade. WIth the announcement of Hydrogen Shot and an increase in DOE funding for hydrogen production, transportation, storage and utilization, CEC should endeavor to work and leverage federal funding including the DOE sponsored consortia to ensure early adoption of clean hydrogen technologies within California. DOE is interested in initiatives to lower the cost of hydrogen, reduce carbon emissions and local air pollution, create good-paying jobs, and provide benefits to disadvantaged communities. The Commission should consider EPIC research and demonstration investments that leverage these federal investments to benefit disadvantaged communities in California.

Consideration should be given for funding regional hubs and public-private partnerships that demonstrate full value across generation, storage, and utilization including novel manufacturing uses for hydrogen. Such a scheme promotes entrepreneurship and opens up the use for hydrogen.

The Commission should further consider next generation technologies beyond electrolysis that require more sustained research and development, including photoelectrochemical hydrogen production, vapor electrolysis, generation tied to geothermal sources of heat, etc. that may leapfrog technologies in the future in terms of efficiency and deployability. Such next generation technologies may provide opportunities to use resources not in use in California today (e.g, tied to offshore wind installations) and eventually reduce cost and thus increase affordability.

In terms of utilization, the Commision has rightly focused on heavy-duty transportation applications. These should include such applications as maritime and rail and aviation, especially for short haul flights within California. While widespread electrification of the light duty fleet is central to the state's decarbonization objective, hydrogen use in light duty applications should remain an option. Such light duty could include autonomous ride shares and similar services that require substantial uptime and quick refueling in places where charging stations may not exist. Focus on myriad transportation technologies will advance affordability and provide resiliency in that mobile fuel cell vehicles can provide power if needed in case of power outages.

Large-scale Geologic Storage of Hydrogen

California curtails thousands of megawatts of electricity from renewable energy sources that cannot be used or stored. Using excess renewable energy to generate hydrogen from water by electrolysis could accelerate California's transition to a carbon-free energy system, enable seasonal storage of energy from renewables, and provide additional benefits for the state's transportation, economic and social goals. The development of large-scale and long-duration hydrogen storage technology is essential for any hydrogen production and utilization concept. Underground hydrogen storage in natural or engineered salt caverns is well established in certain locations such as Houston. Salt deposits are rare geologic formations, however, restricting the establishment of hydrogen storage in California and elsewhere in the United States. Depleted natural gas reservoirs could provide abundant, economic and safe options. Many depleted gas reservoirs in the San Joaquin Valley are likely suitable, are located relatively close to major solar and wind power plants, and the development of hydrogen would have economic and health benefits.

Geologic hydrogen storage has much in common with geologic methane storage, a mature approach with more than 270 wells under active use in California (WellFinder). Underground gas storage can be performed safely and securely. The 2015 Aliso Canyon blowout was caused by well casing corrosion and not failure of geologic confinement. Although hydrogen storage in depleted gas reservoirs has been previously proposed, important questions about efficiency and economics have not been answered. Hydrogen gas is more diffusive, more chemically reactive and more biologically available than methane, suggesting there could be pathways for hydrogen losses that diminish roundtrip storage efficiency. Work performed recently in the United Kingdom (Dr. K. Edwards, pers. comm.) indicates that these potential issues are minimal and manageable, but research is required to assess the specific geology of wells in California.

Significant advances in evaluating the feasibility of hydrogen storage in depleted gas reservoirs would be achieved by an integrated laboratory and field study with the following tasks and goals:

A pilot injection of hydrogen gas into existing injection well in depleted gas field would provide essential experience and quantitative information on the following aspects:
1. Engaging with the local communities during planning, siting and execution
2. Demonstration of safe containment of hydrogen gas or gas blend
3. Coupled monitoring and reservoir modeling of injection and withdrawal
4. Recoverability of hydrogen and analysis of potential contaminant co-extraction

Laboratory studies of hydrogen gas interactions with relevant geologic samples would quantify the potential for the loss of underground hydrogen via the following mechanisms:
1. Hydrogen diffusion through geologic caprock
2. Chemical reactions consuming hydrogen
3. Microbiological reactions consuming hydrogen

Supporting this research project with analysts from relevant institutions and companies (including CEC, national labs and universities, utilities, renewable energy companies, HyDeal LA) would enable optimal siting and integration. Coordination with large-scale efforts such as the HyDeal LA project which could provide synergistic benefits including:
1. The HyDeal project used modeling to evaluate the efficiencies and economics for hydrogen transport through gas pipeline versus electricity transmission, information that would be relevant to siting this project.
2. Both efforts have common technical questions around the potential for hydrogen gas embrittlement of steel used in pipes and well casing.

For any form of large-scale hydrogen storage, the following additional projects are also warranted
1. Development of hydrogen gas monitoring for leak detection
2. Development of hydrogen isotope monitoring for source attribution
3. Assessment of atmospheric chemistry of hydrogen, a secondary greenhouse gas

Geologic storage of hydrogen could be deployed in several ways to increase the resilience of electricity delivery in California. Transitioning depleted methane wells to hydrogen storage would provide new opportunities for small and large oil and gas businesses, and their trained workforce, to flourish in a carbon-free future. Coordinating this proposed project with UC and Cal State campuses would enable education and training opportunities for a next-generation workforce. Further, significant health benefits are anticipated for communities impacted by oil and gas extraction and petrochemical industry. Specifically, the establishment of a large-scale hydrogen storage approach would aid the energy transitions that reduce pollutant emissions from carbon combustion. Finally, the large-scale storage of hydrogen gas is a critical enabling technology for a hydrogen ecosystem. Successful demonstration of geologic storage would significantly lower a barrier for establishing a hydrogen economy in California, which could offer new economic and employment opportunities in historically underserved communities.

By one estimate, the depleted gas reservoirs in CA are easily able to store all currently curtailed electricity (e.g. 225,000 MWhr in May 2019, CAISO). This is based on the efficiency of current electrolyzers, and accounting for energy required for compression, an electricity-to-hydrogen conversion of 40 tons per MWHr, and the methods used in recent wells for hydrogen storage in the U.S. and the United Kingdom. The proposed research project would extend modeling and site selection.

The techno economic case for hydrogen as an energy storage medium depends principally upon the capital cost of the electrolyzer, electrolyzer efficiency, the cost of electricity, the capital cost for establishing the reservoir, the operational costs for injection and withdrawal, and the revenue from selling the hydrogen for applications that can include electricity generation (burning in a turbine or using a fuel cell), as a transportation fuel or for manufacturing. In the present concept, the repurposing of existing depleted gas reservoirs would avoid expenses for new drilling or for manufacturing tanks or other storage approaches. The proposed research project would allow the costs of well operation to be established.

On behalf of Berkeley Lab, we appreciate the opportunity to provide these comments on the EPIC 4 Investment Plan.

Sincerely,

Alecia Ward
Leader, Program and Business Development
Energy Technologies Area
award@lbl.gov

Jim Hawley
Director, State and External Relations
jchawley@lbl.gov